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"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

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Volume 7

Sacramento, January, 1921

Number 1



SALMON NUMBER

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CONTENTS.

	PAGE
THREE CALIFORNIA MARKED SALMON RECOVERED..... <i>J. O. Snyder, Stanford University</i>	1
AN INSTANCE OF ADULT, SEA-RUN CHINOOK SALMON FOUND FEEDING IN FRESH WATER..... <i>Willis H. Rich, Field Assistant, United States Bureau of Fisheries</i>	7
STEELHEADS CAUGHT AT SEA OFF THE COAST NEAR FORT BRAGG..... <i>J. O. Snyder, Stanford University</i>	9
THE RELATIVE MATURITY OF THE CHINOOK SALMON TAKEN IN THE OCEAN ALONG THE PACIFIC COAST..... <i>Willis H. Rich, Field Assistant, United States Bureau of Fisheries</i>	12
GEAR USED FOR SALMON TROLLING IN CALIFORNIA IN 1920..... <i>W. L. Scofield</i>	22
THE FUTURE OF THE SARDINE..... <i>Will F. Thompson</i>	38
EDITORIALS	42
FACTS OF CURRENT INTEREST.....	48
HATCHERY NOTES	49
COMMERCIAL FISHERY NOTES	54
NOTES FROM THE STATE FISHERIES LABORATORY.....	59
LIFE HISTORY NOTES.....	62
CONSERVATION IN OTHER STATES.....	65
REPORTS—	
VIOLATIONS OF FISH AND GAME LAWS.....	68
SEIZURES	68
EXPENDITURES	69
FISHERY PRODUCTS, JULY, AUGUST, SEPTEMBER, 1920.....	70

THREE CALIFORNIA MARKED SALMON RECOVERED.

By J. O. SNYDER, Stanford University.

Three marked king salmon were secured last summer by W. L. Scofield, who was engaged in making observations for the Fish and Game Commission. Each of the three specimens had the adipose and left ventral fins excised. The mutilations were of such a nature that they could not be attributed to any other causes than the methods used in marking small fish. One was taken at Monterey, April 6. It measured 73 centimeters. Along with others it was eviscerated before anything unusual was noticed regarding the fins. The sex, therefore, could not be determined with certainty. The second was caught at Shelter Cove

and brought to Fort Bragg, August 17. It was a male, which measured 71 centimeters and weighed $8\frac{1}{4}$ pounds. The third was caught in the Sacramento River near Pittsburg. It, too, was a male and measured 68 centimeters. These three fish are the first captured from some marked ones liberated in the Sacramento River in 1918.

Mr. W. H. Shebley writes concerning these fish: "The eggs were collected during the fall of 1916 at the Bureau of Fisheries stations

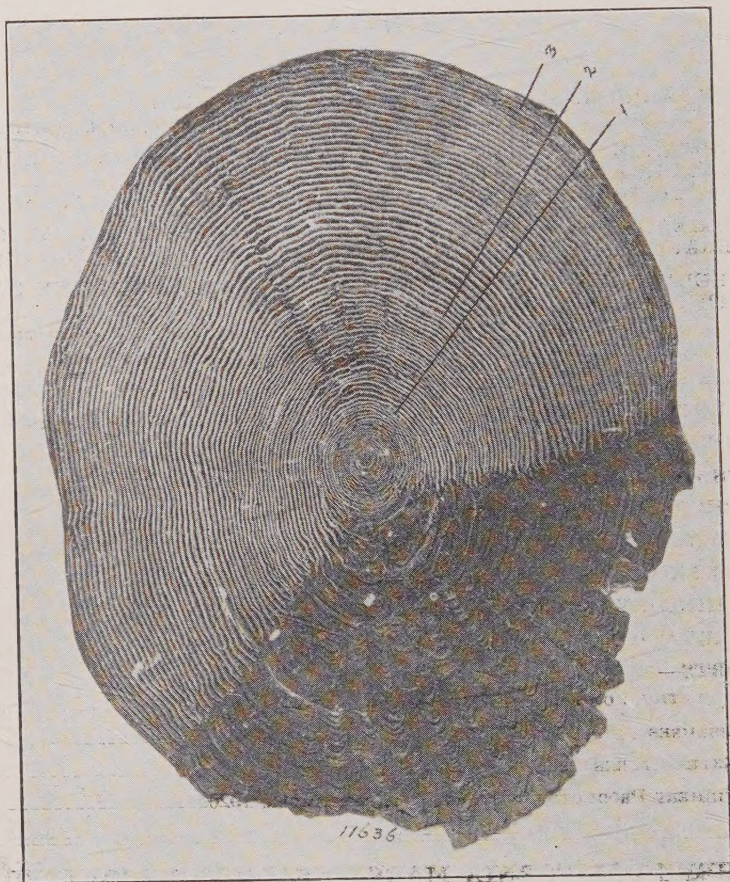


FIG. 1. Photomicrograph of scale of salmon marked at the Mount Shasta Hatchery in 1917 and taken at Monterey, April 6, 1920. Length 73 centimeters. Numerals mark the end of the first, second and third years of growth.

on the Sacramento River. The resulting fry were put in Sisson Lake in the spring of 1917 and held until October of the same year. They were then placed in the small rearing ponds at Mount Shasta hatchery. The fry were marked during November and December, 1917. These to the number of 18,000 were distributed in Cold Creek, a tributary of the Sacramento River, on March 19, 1918."

A photomicrograph of a scale from each of these fish is presented. It will be seen at a glance that the Pittsburg specimen differs markedly

from the others in that the edges are frayed or worn. This frayed appearance of the scales was characteristic of all fish observed at the time, and it plainly indicates that the absorption of reserve tissues was already in progress, a condition just preceding the breeding period. The fish from which this scale was taken was very dark in color, and the snout had become elongated and hooked.

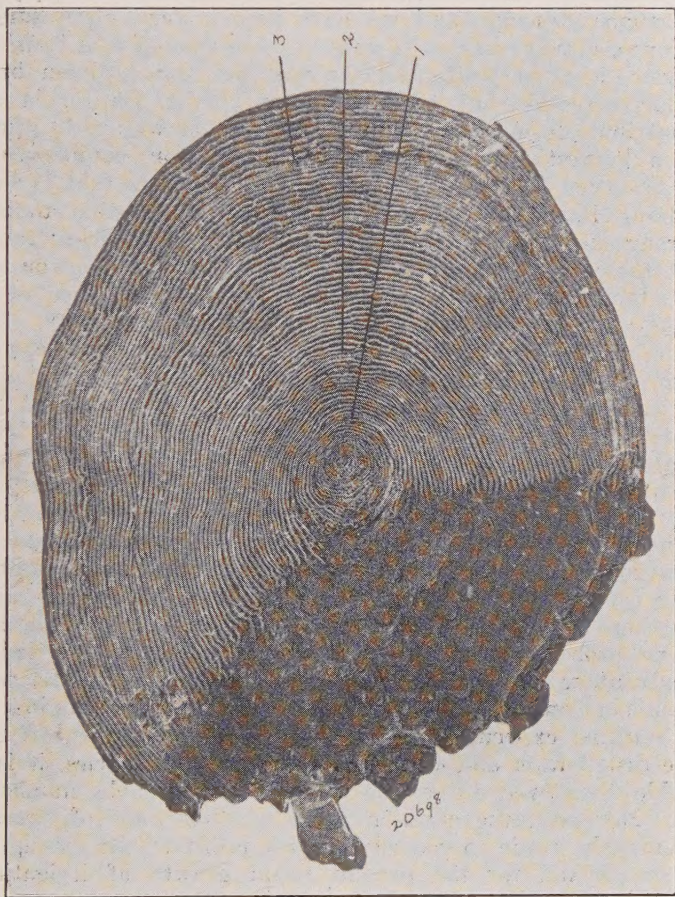


FIG. 2. Photomicrograph of scale of salmon marked at the Mount Shasta Hatchery in 1917 and taken in Shelter Cove, near Fort Bragg, on August 7, 1920. Sex, male; length 71 centimeters; weight 84 pounds. Numerals mark the end of the first, second and third years of growth.

A nuclear area of closely apposed rings appears near the center of each scale. This area corresponds with the period in the fish's life spent in fresh water, including the lake, pond and river. The nuclear area is surrounded by alternating bands of broad and narrow rings representing times of rapid or slower growth, which may be interpreted in periods of years, the second year growth ending at 2, the third at 3, while the fourth is in progress. The rapid growth of the fourth year was

early interrupted in the case of the Monterey fish, while allowed to progress farther in the Shelter Cove and Pittsburg examples.

The most valuable information coming to us with the capture of these marked fish is that the sea range of Sacramento salmon not only embraces Monterey Bay to the southward, but that it extends far northward as well. Now there is urgently desired at the present time some definite information regarding the source of supply of the marine salmon fisheries, and we have here a very plain suggestion as to the procedure necessary to gain at least some of that information. To be sure, it is perfectly well known that these salmon breed in certain large streams, but it is not known whether California streams alone contribute to our ocean supply, or whether we are in a measure reaping a harvest from seed sown north of our boundaries. The opinion has been freely expressed in some quarters that the salmon of Monterey Bay are from the Sacramento River, that those from Fort Bragg and Shelter Cove are from streams entering the ocean north of these localities, and in short, that young salmon on migrating into the ocean progress southward from their place of entry, where they live and grow until the approach of maturity. With a firm belief in the theory of southward migration, some fishermen and others of experience will even pretend to identify Columbia River salmon among those caught near Fort Bragg. We have at present very little to show that their belief is not well founded, but they have still less to demonstrate that it is. The capture of this marked Sacramento River fish at Shelter Cove, a long distance north of the mouth of the river, is then easily seen to be a matter of considerable importance. The evidence derived from a single example should not be overestimated, however, and it seems evident that only investigation involving carefully planned experiments will be of definite aid here and elsewhere in a profitable study of the life history of the salmon. It is very probable that such investigation might be carried on to better advantage in a stream much smaller than the Sacramento, for when one comes to consider the difficulties of obtaining results from a marking experiment, for example, in a very large river with the wide distribution and varied character of its fisheries, it is really remarkable that even three fish from a considerable number were secured. Moreover, the question as to whether some of our smaller streams may be made to contribute with profit to sea fishing is well worth considering, for the present rapid growth of irrigation and power projects, which seriously interfere with the natural breeding grounds of salmon in the Sacramento and Klamath rivers, foreshadows the time when some attention will be directed elsewhere if we seriously care to maintain our supply of these fish.

There is one point of interest connected with these scales to which, however, one is not as yet warranted in attaching any real significance. It will be observed that in the Shelter Cove scale, and particularly in that from the Sacramento River, the annual checks are very marked, while in the Monterey specimen they are much less distinct. A comparison of a large number of scales from the region of Fort Bragg and Shelter Cove, with many from Monterey Bay, seems to give the impression that the presence of sharply defined annual checks is not very characteristic of scales of Monterey salmon, but that, in contrast

with those from the region of Fort Bragg, they are much less pronounced and in many cases difficult to detect. Although one is not prepared to even speculate as to the reason for this, especially since the cause of the growth check is not known, it is, at any rate, of passing interest to observe that in the character of the growth check both the Monterey and Shelter Cove scales conform to what appears to be the fashion in each locality. And if appearances are not misleading, one would be tempted to suspect that the Sacramento fish

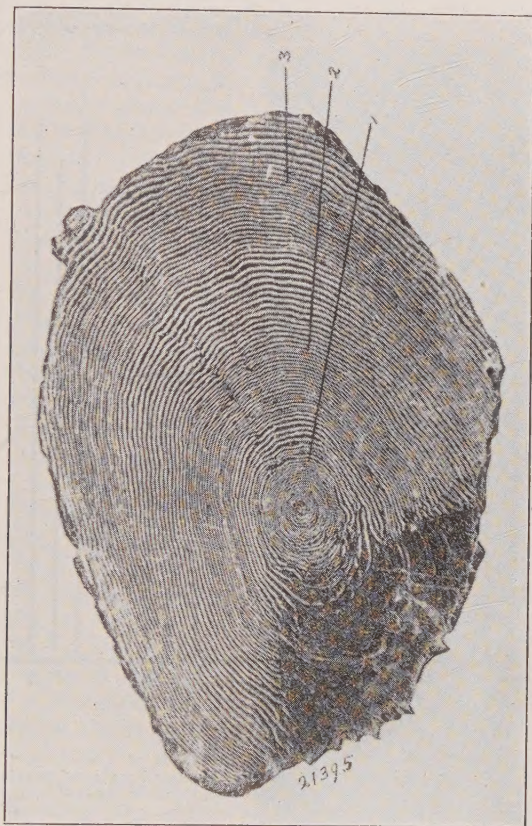


FIG. 3. Photomicrograph of scale of salmon marked at the Mount Shasta Hatchery in 1917 and taken in the Sacramento River at Pittsburg, September 15, 1920. Sex, male; length 68 centimeters. Numerals mark the end of the first, second and third years of growth.

had spent its sea life in the region of Fort Bragg or Shelter Cove. Furthermore, if we calculate the length attained by each fish at the end of the second and third years, which may be done with some degree of accuracy from measurements obtained from the scales, it will be seen that the Shelter Cove and Pittsburg specimens agree in being smaller than the one from Monterey.

Monterey	-----second year 30 centimeters ; third year 71 centimeters
Pittsburg	-----second year 27 centimeters ; third year 55 centimeters
Shelter Cove	-----second year 22 centimeters ; third year 59 centimeters

This may be only a matter of coincidence, but interest will not be lost after a comparison of a number of fish from Fort Bragg and Monterey. From the scales of a hundred fish caught in Monterey Bay, and which had apparently entered the sea as yearlings, the average length at the end of the second and third years was computed. The same was done with a like number of similar fish from the vicinity of Fort Bragg. In both cases the specimens were taken at random as they appeared in the catch. The result was as follows:

Monterey -----second year 38 centimeters; third year 65 centimeters
 Fort Bragg -----second year 35 centimeters; third year 59 centimeters

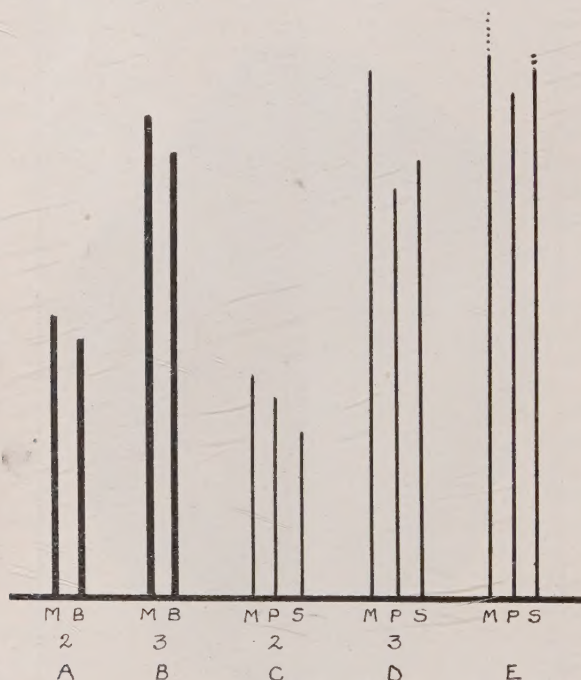


FIG. 4. Diagram showing the average length of marked and unmarked salmon, at two and three years of age, taken at various places.

A simple diagram will serve well to show these comparisons. A and B represent the average lengths at 2 and 3 years, M being the fish from Monterey, and B representing those from Fort Bragg, including Shelter Cove. C and D are the lengths of the marked fish from Monterey, Pittsburg and Shelter Cove at the end of second and third years. E represents the lengths of these fish at time of capture, the dotted tips indicating that growth was interrupted by capture before maturity.

Judging from the experience of investigators who have experimented with the marking of salmon, we may expect to see more of these fish in the fifth year. Their capture will be awaited with interest.

AN INSTANCE OF ADULT, SEA-RUN CHINOOK SALMON. FOUND FEEDING IN FRESH WATER.*

By WILLIS H. RICH, Field Assistant, United States Bureau of Fisheries

During the course of the writer's investigation of the salmon of the Columbia River, it was learned, through apparently reliable sources, that the chinook salmon which entered the Cowlitz River during the early spring were feeding upon the smelt or eucalon (*Thaleichthys pacificus*) which run in large numbers at this time of year.

The Cowlitz River empties into the Columbia River nearly seventy miles above the mouth of the latter—well above the highest reach of brackish water. It is well known that the habit of adult salmon, entering streams for the purpose of spawning, is to cease feeding at least as soon as the fresh water is entered. In many cases the fish apparently cease to feed as soon as they leave the open ocean and definitely begin the journey to the spawning grounds even though the first part of the journey may be through pure, or nearly pure sea water. This is true of the Fraser River sock-eyes which enter Puget Sound through the Strait of Juan de Fuca and which cease to feed as soon as the journey through the strait has begun.† The mature salmon taken just within the mouth of the Columbia River have ceased feeding although the water is only slightly fresher than sea water. Numerous other examples illustrating the same point might be cited. In view of these facts, the feeding of salmon so far from the ocean as the Cowlitz River formed a remarkable contradiction to the usual habit and it seemed desirable to fully investigate the report. On



FIG. 5. Stomach of an adult sea-run Chinook salmon found feeding in the Cowlitz River, Washington. As a rule the stomach of a salmon found in fresh water shows no evidences of its being in use.

account of the spring closed season no commercial fishing for salmon was being carried on at the time the smelt were the most plentiful and it was necessary to make special efforts to secure specimens. On April 14, 1916, in company with a fisherman and one of the state fish wardens, several drifts with a gill net were made in the Cowlitz River

*Published by permission of the U. S. Commissioner of Fisheries.

†This is described by Gilbert in his paper on The Salmon of Swiftsure Bank, Report of the Commissioner of Fisheries, Province of British Columbia, 1912 (1913), page 116.

just below the town of Kelso. One chinook was finally secured—a female weighing about 25 pounds. The examination fully confirmed the reports, as the stomach contained upward of a dozen smelt in various stages of digestion. The stomach, partially dissected in order to expose the contents, is shown on the previous page.

This unusual habit is without doubt occasioned by and associated with the presence of enormous numbers of smelt. These smelt enter the Cowlitz and a few other tributaries of the Columbia River for the purpose of spawning and, at the height of the season, are gathered in close schools in small restricted localities. The laying of the eggs is apparently accomplished while they are thus aggregated. Evidently these conditions as found in the Cowlitz, where large numbers of small fish are closely schooled, approximate the normal feeding conditions as found in the ocean. Similar habits of the salmon will doubtless be found in other streams which have runs of smelt or other small anadromous fishes coinciding with a run of chinook salmon. Other species of salmon may also have a similar habit. It is probable that the salmon have followed the smelt run in from the ocean and that they continued to feed while passing up the main river and into the Cowlitz. This seems more likely than the alternative, that they had ceased feeding on leaving the ocean but began again on entering the Cowlitz.

In this connection it should be noted that the precocious male salmon which have matured after spending the first year in fresh water continue to feed even after the sex products have ripened. Such precociously mature males are commonly found both among wild fish and among those which have been reared in hatchery ponds. In certain instances it has been noted that these mature yearlings have recovered from the effects of maturity and have survived—contrary to the rule in the case of sea-run adults.*

It would seem that this is chiefly on account of the fact that the normal food supply has been constantly present so that it has not been necessary for the fish to cease feeding during the spawning period. The fact that adult, sea-run salmon will frequently take the hook when well into fresh water is further evidence that the normal feeding reaction is not disturbed merely by the entrance into fresh water. At many places chinook salmon may be taken by trolling with large spoon hooks. The salmon fishing at the Oregon City Falls on the Willamette River is well known. The steelhead fishing on other western streams, particularly the Rogue River, has a wide spread reputation, as has also the fishing for Atlantic salmon in Maine and Canada. In many cases these fish are taken hundreds of miles above the mouth of the streams.

It may be concluded from these observations that one of the factors which cause salmon on entering a stream for the purpose of spawning to cease feeding is the lack of a normal food supply. In the particular instance herein described, a normal food supply was present, with the result that the fish fed in a normal manner. It is possible that a longer residence in fresh water or the nearer approach of the spawning season would cause the fish to cease feeding even though a normal food supply was available.

* Early History and Seaward Migration of Chinook Salmon in the Columbia and Sacramento Rivers. By Willis H. Rich. Bulletin of the Bureau of Fisheries, XXXVII, 1919-20. Doc. 887, page 67.

STEELHEADS CAUGHT AT SEA OFF THE COAST NEAR FORT BRAGG.

By J. O. SNYDER, Stanford University.

Trollers fishing for salmon off the coast north of San Francisco have reported the capture of steelhead trout at sea. None of these trout has been available for study until this summer, when W. L. Scofield, while making observations for the Fish and Game Commission at Noyo River near Fort Bragg, was fortunate enough to separate 16 specimens from the mass of king and silver salmon brought in there. Material was preserved so that no doubt is involved in the identification of these fishes. From the collector's notes the following paragraph is taken:

The first steelheads appeared July 23, and the last one was seen August 25. On August 14 five specimens were found, and again on



FIG. 6. Noyo Estuary, showing salmon fishing boats. Photograph by J. O. Snyder, 1920.

August 16 the same number were secured. In color they were of the characteristic steel blue above and bright silvery on the sides; the dark upper surface with small blackish spots, numerous on some examples, less abundant on others; the head with few or no spots. The dorsal, adipose and caudal fins were spotted, the size and number of spots varying considerably in different individuals. The pectoral and ventral fins were immaculate except for dark anterior margins. The lateral series of scales as recorded from twelve individuals number from 132 to 143, the count being made to base of caudal fin; the series from lateral line to back 25 to 34. They measured 19 to 29 inches, and weighed $2\frac{3}{4}$ to $9\frac{3}{4}$ pounds. There were eleven males.

These fishes are regarded as examples of *Salmo irideus*, the rainbow trout. This identification is based on what appears to the writer as a well-founded assumption, that but two species of trout* inhabit

* Bureau of Fisheries Document No. 638, page 183.

the costal region of California. *S. irideus* and *Salmo clarkii*, the cutthroat trout, sea living individuals of both being known as steelheads.

The steelheads enter the rivers to spawn, their progeny in turn migrating to sea where food is plentiful, or remaining for an indefinite time in fresh water as the case may be, the latter being recognized as stream trout. The rainbow trout is a large scaled form, there being about 110 to 150 series of scales on the body, while the cutthroat has smaller scales, about 150 to 200 series. In their distribution the two species overlap, both occurring in the coastal streams from Redwood Creek northward.

In spite of the fact that these steelhead trout have been known for many years and that they are of considerable economic importance, our store of carefully observed and recorded facts concerning them is very meager. Some observations have lately been made on the Klamath, in which river both species enter from the sea and migrate for



FIG. 7. Noyo Estuary, showing canneries. Photograph by J. O. Snyder, 1920.

spawning purposes. Here there are two fairly distinct migrations of steelheads, one occurring in the winter, the other in the summer. Of the winter run we know very little; nothing, in fact, of what species it is composed. The summer run consists almost entirely of *S. irideus*, an example of *S. clarkii* occasionally appearing. The latter may be spoken of as one among thousands in the migration of the former. In the summer of 1919* the first steelheads were taken in salmon nets on July 11; the largest number were caught about August 27, and the run had about ceased October 22. The progress of the steelhead migration coincided in general with that of the king salmon, not only in its rise and decline, but in its periodical irregu-

* Agents of the Fish and Game Commission have been making observations on the trout and salmon for two summers in the estuary of Klamath River. Through the kindly interest of Mr. G. R. Field, they have been enabled to examine thousands of individuals, which his fishermen have taken.

larities as well, a large wave of steelheads being generally associated with a similarly large wave of salmon.

As these steelheads appear fresh from the ocean, many still bearing living salt water crustacea attached to their bodies, they are of a beautiful deep steel blue above, with highly burnished silvery sides. They have usually very definite black spots on the head and body, they are always present on the dorsal, adipose and caudal fins, while the remaining fins are immaculate. Sometimes the head is without spots and the body has very few. Counts on a number of examples resulted as follows: Head spots, 0 to 25; body, 8 to 271; dorsal fin, 47 to 98; adipose, 1 to 9; caudal, 14 to 220. The spots of the head are almost always round; those of the body elongate or linear. The ova found in these fishes are very small, their undeveloped condition giving rise to the suggestion that the steelheads have entered upon a very long migration or at least a considerable period in fresh water. Their stomachs are mostly empty, and they remain so at least while they are in the estuary for the very simple reason that there is not food enough in the river to supply such a horde, were its members inclined to eat. They occasionally strike a spinner, but they will not rise to fly, nor are they often attracted to a baited hook. Later in the season and farther up stream their appetites are said to return, and their behavior is governed accordingly. About the middle of August, steelheads that have begun to assume their nuptial colors are occasionally seen in the estuary. The cheeks become tinted with pink, and a broad reddish blush appears along the sides. At the same time the dark dorsal area loses its marine hue and becomes light olive. No salt water crustacea are found attached to these tinted individuals, and it appears probable that they have been in fresh water for some time. The steelheads fresh from the sea are plump, fat and full of energy. At times they have been seen in numbers leaping high from the water and falling with a resounding splash, in strong contrast to the salmon which only cut the surface with their backs and tails.

The largest steelhead caught in the Klamath is said to have weighed 32 pounds. Those which appear from day to day are much smaller. For example, on August 13 and 14 of this year, 248 specimens that were caught in gill nets measured $14\frac{1}{2}$ to 32 inches and weighed $1\frac{1}{2}$ to $14\frac{3}{4}$ pounds. The entire lot gave an average weight of 5.86 pounds; 10.862 examples showed an average weight of 4.3 pounds. Small fishes are not apt to become entangled in the coarse meshes of the drifting gill nets, and it is therefore of interest to find that a fine meshed seine will bring from the river not only large specimens but smaller ones as well, individuals 8 or 10 inches in length having been taken which exhibit every detail of color possessed by the larger steelhead fresh from the sea. Whether these small fishes have just come in from the ocean we are unable at present to say.

The scales of these Klamath steelheads which are identified as *Salmo irideus*, rainbow trout, number 116 to 150 in the lateral series. The steelhead trout taken at sea near Fort Bragg are of the same species as those that enter the Klamath in the summer in such large numbers. They may even be Klamath trout for all that we know, but it seems more reasonable to assume that their parent stream is somewhere nearer their place of capture.

THE RELATIVE MATURITY OF THE CHINOOK SALMON TAKEN IN THE OCEAN ALONG THE PACIFIC COAST.*

By WILLIS H. RICH, Field Assistant United States Bureau of Fisheries.

This paper is in the nature of a preliminary report dealing with the maturity of the chinook salmon taken by troll and purse-seine in the ocean along the Pacific coast, and is presented for the purpose of making immediately available some of the results of the investigation. It is also believed that the method used for determining the relative maturity is new and may be of value to others engaged in similar investigations. A later report will give in detail the data upon which the conclusions presented in this paper are based, and will discuss several topics treated very briefly, or omitted entirely from this paper.

The amount of trolling and purse-seining for chinook salmon along the Pacific coast has increased enormously during the past few years, especially along the northern coast of California, the coast of Oregon, and off the mouth of the Columbia River. To anyone who has observed even casually the fish thus taken in the ocean it is perfectly apparent that a great proportion are immature and it is a point of considerable interest and practical importance to know just what percentage are immature and the relative degree of immaturity. The determination of the age by means of scale studies will not, alone, give a sufficient index to the degree of immaturity since there is such a wide range in the age at which these fish reach the spawning stage—from two to six years. If the percentages of individuals of different ages among the mature fish were constant, it would be possible, from a determination of the percentages of fish of different ages taken by troll and purse-seine in the ocean, to estimate the percentage of fish of different degrees of maturity. This, however, is not the case. The percentages of fish of the various age-groups vary greatly at different times among the mature fish and also among those taken in the ocean. Presumably these variations are due quite largely to racial differences but our present knowledge of the various races of chinook salmon is quite too limited to aid in segregating the races from mixed lots. Even if our knowledge of the races were complete it might well be that they could not be identified and segregated accurately and fully enough to serve the purpose. It is apparent that some other means than the determination of the age is necessary in order to learn the percentages of mature and immature fish taken in the ocean and their relative maturity.

The method which has been developed for determining the relative maturity is based upon variations in the size of the eggs. Obviously this can be applied only to the females and no method has yet been devised for determining the relative maturity of the males. The percentages of males and females found among the mature fish of the various age groups will give some basis for estimating the percentages of mature and immature males from the determination of the relative maturity of the females, but a discussion of this topic must be reserved

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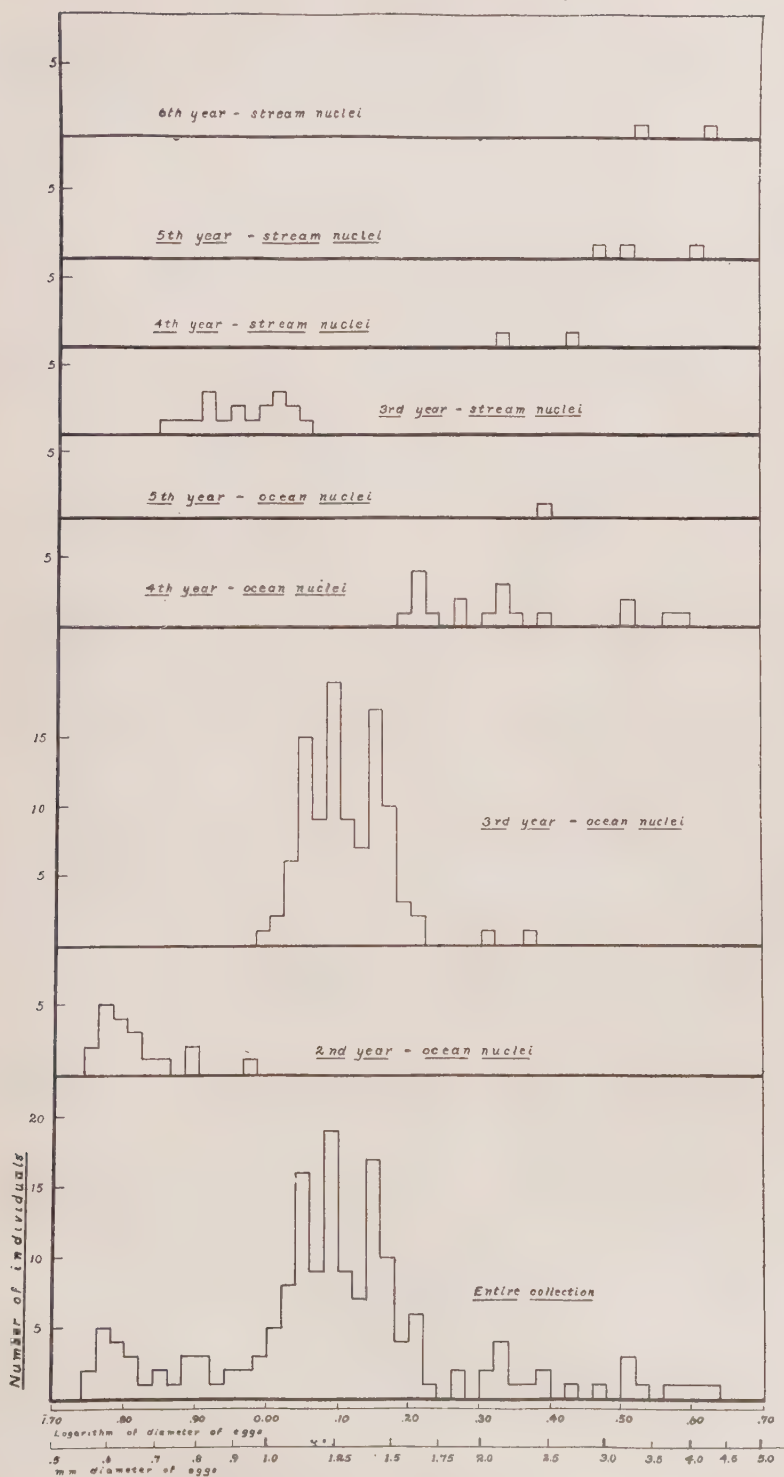


FIG. 8. Histogram showing frequency-distribution of 163 female salmon taken by troll off the mouth of the Columbia River, May 8, 1919, based on

for the complete report. It is sufficient to state here that, while there is a tendency for the males to mature somewhat younger than the females, the error which would result from assuming that the proportions of fish of similar degrees of maturity were equal in the males and females would not be serious.

Superficial examination of the eggs found in the females taken in the ocean shows that there is a wide diversity in the size and, further, that several more or less distinct size-groups are distinguishable even without careful measurement. It is a natural assumption that these various sizes of the eggs indicate different degrees of maturity. A careful study of several collections of fish taken within the Columbia River and by troll off the mouth of the Columbia, in Monterey Bay, California, and along the northern coast of California confirms this assumption and shows that, by means of a study of the variation in the size of the eggs and a determination of the age by means of the scales it is possible to distinguish, with certainty, in many cases, and with reasonable probability in most, between fish which would have spawned during the year in which they were taken and those which would not have spawned for at least one more year. The distinction between fish which would not have spawned for two years is not quite as definite but in some collections the interpretation is clear.

In studying these collections the age has been determined by the usual method of scale study. The size of the eggs has been determined by measuring ten of each sample and taking the average. The larger eggs—those over 1 mm. in diameter—were measured in a simple device

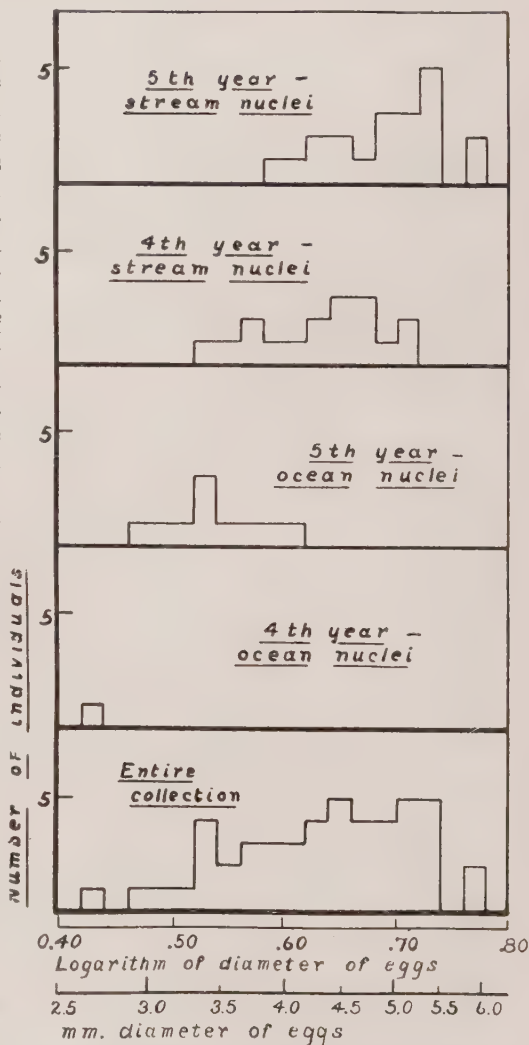


FIG. 9. Histogram showing frequency-distribution of 48 females taken by beach seines and wheels near Warrendale, Oregon, June 16, 1919, based on the logarithms of the diameters of the eggs.

which consists essentially of a small trough, V-shaped in cross-section and with closed ends, which is graduated in millimeters. In use this is partially filled with water, the eggs are placed in a row in the bottom

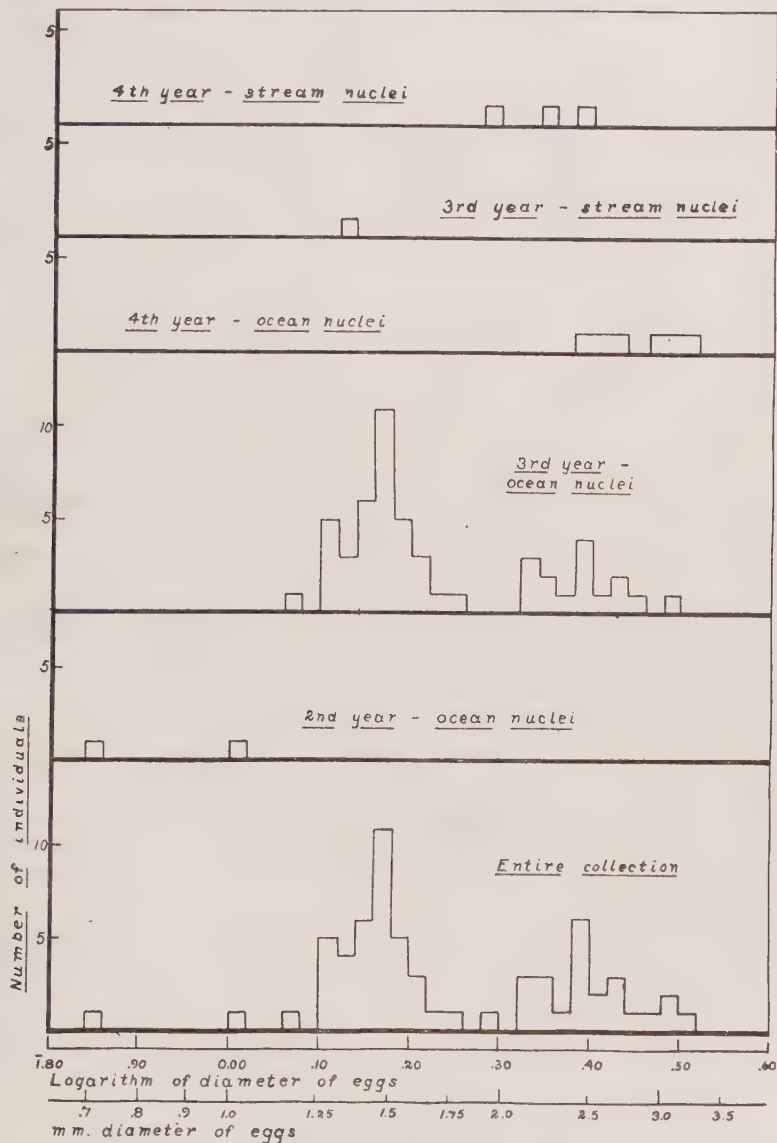


FIG. 10. Histogram showing frequency-distribution of 63 females taken by troll in Monterey Bay, California, June 19-21, 1918, based on the logarithms of the diameters of the eggs.

of the trough, and then are carefully pushed up to the zero end of the scale by means of a small piece which fits the bottom of the trough and on which is graduated a vernier enabling one to read accurately to tenths of a millimeter. The measurement of ten eggs by this scale

gives directly, by simply moving the decimal point one place to the left, the average size of the eggs to hundredths of a millimeter. As a matter of fact this measurement is finer than is necessary in the great majority of cases. In preparing eggs for this measurement it is necessary to free them very carefully from the ovarian membranes so as not to break the delicate shell and yet to clear them of all shreds of tissue which might tend to affect the measurement. The smaller eggs—those less than 1 mm. in diameter—were measured by means of a microscope fitted with an eyepiece micrometer carefully standardized. In using this method it was necessary, of course, to measure the ten eggs separately and then the average of these measurements was found.

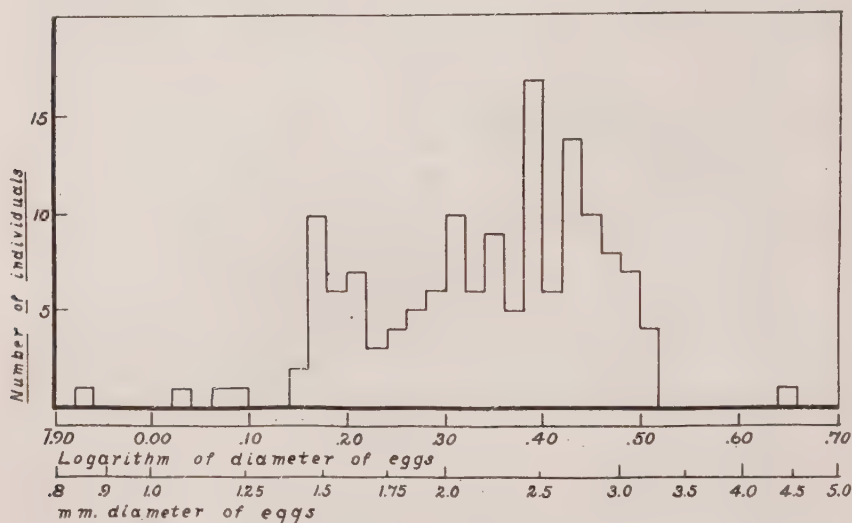


FIG. 11. Histogram showing frequency-distribution of 144 females taken by troll in Monterey Bay, June 29, 1915, based on the logarithms of the diameters of the eggs.

The tabulating and plotting of these egg measurements has been done on a logarithmic basis—that is, the logarithms of the actual measurements have been tabulated rather than the measurements themselves. The main advantage of this sort of tabulation lies in the fact that proportional variations in size are equally shown independent of the actual size, and it is the relative size of the eggs, rather than the actual diameter, which is significant.¹

In preparing the tables and charts the classes have been arranged with intervals of .02 in the logarithm of the diameter of the eggs. This signifies that the mid-value of each class is 4.713 per cent greater than that of the class next preceding.

The following collections have been used in the preparation of this preliminary report:

1. 163 females taken by troll off the mouth of the Columbia River, May 8, 1919.
2. 68 females taken by troll off the mouth of the Columbia River, June 4, 1919.
3. 48 females taken by beach seines in the Columbia River near Warrendale, Oregon, June 16, 1919. (Warrendale is approximately 150 miles above the mouth of the river.)

¹ The writer is indebted to Prof. F. W. Weymouth of Stanford University for an acquaintance with this method of tabulating.

4. 48 females taken by traps in Baker Bay, Columbia River, July 3, 1919. (Baker Bay and Sand Island, where the next collection was taken, are both just within the mouth of the river.)

5. 41 females taken by beach seines on Sand Island, Columbia River, July 6, 1919.

6. 101 females taken by troll off the mouth of the Columbia River during August 13 to 17 and September 16 to 17, 1918. (But five of these were taken in September and these have been considered with the August collections.)

7. 95 females taken by troll off the mouth of the Columbia River, August 13, 1919.

8. 63 females taken by troll in Monterey Bay, California, June 19 to 21, 1918.

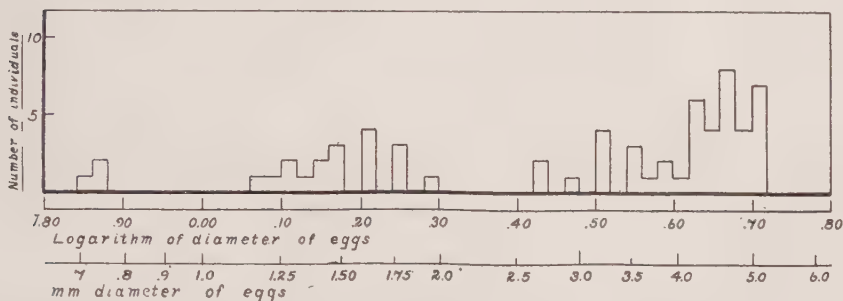


FIG. 12. Histogram showing frequency-distribution of 64 females taken by troll near Drake's Bay and Fort Bragg, California, July and August, 1918, based on the logarithms of the diameters of the eggs.

Full data including scales were taken with each of the above collections. In addition to these the following two collections consisting of eggs alone were studied:

9. Eggs from 144 females taken by troll in Monterey Bay, June 29, 1915.

10. Eggs from 64 females taken by troll near Drake's Bay, August 15 and 16, 1918, and Fort Bragg, July 17, 1918, on the coast of northern California. Scales and data were also collected from the females at the same time the collections of egg samples were made, but the records were not kept so that the egg samples could be referred to the corresponding data and scales. It has been necessary, therefore, to treat egg samples and other data independently.

It will be impossible, in this report, to give in detail the evidence necessary to prove the validity of this method for determining the relative maturity. The graphs will, however, give illustrations of typical results obtained from the measurement and tabulation of the eggs. An examination of the graphs shows that, in the collection of undoubtedly mature fish from Warrendale, the eggs were fairly uniform in size, ranging from about 2.5 to 6 mm. in diameter. The obvious graduation in size of the eggs in the different age-groups is probably significant of racial differences, but a discussion of this point cannot be given in this paper. In the case of the fish taken by troll in the ocean the frequency-distribution based on egg sizes shows a distinct grouping around several modes which are usually quite well separated.

Three modes are especially distinct and, in the case of the collections for which age determinations were also made, and which have, therefore, been separated into the component age-groups (Monterey, 1919, and Columbia River, May, 1919) it is apparent that the group characterized by the largest eggs (above 2 mm. in diameter) is composed chiefly of

fish in their third, fourth and fifth years, whose scales show the ocean type of nucleus, and of fish in their fourth and fifth years whose scales show the stream type of nucleus. [The nuclear growth here referred to is that located close to the center of the scales and represents the portion of the scales formed during the first year. The "stream" type indicates that the fish remained in the stream during the entire first year of its life. The "ocean" type of nuclei indicate that the fish have migrated seaward sometime during the first year, usually early.]

The group representing the next smaller size of eggs (1.25 to 1.5 mm.) in diameter is characterized especially by fish in their third year with either ocean or stream nuclei, while the group representing the smallest eggs (.6 to .8 mm.) is characterized chiefly by fish in their second year with ocean nuclei. The size of the eggs in the group having the largest eggs corresponds, in each instance, with the size of eggs in the Warren-dale collection and are, therefore, without doubt fish which would have matured during the year in which they were taken.

It is apparent, then, that in general the group characterized by the largest eggs is composed of fish one year older than those composing the group with eggs of the next smaller size, and that these in turn are one year older than those composing the group with the smallest eggs. These differences in the size of the eggs are not dependent on corresponding differences in the size of the fish. There is, indeed, a distinct correlation between the size of the fish and the size of the eggs, but, as will be shown in the more detailed report, this correlation is by no means ample and is unquestionably modified by the approach of maturity. Of particular interest and significance is the presence of two groups of individuals within the same age-group which may be definitely separated on the basis of egg sizes. This is shown with unusual clearness in the third year fish with ocean nuclei taken at Monterey in 1918. The group with eggs greater than 2 mm. would undoubtedly have spawned during the fall of the same year in which they were taken, while the fish composing the other group would not have spawned for at least one more year. These facts which have been so briefly and incompletely discussed seem to fully justify the conclusion that the size of the eggs is a fairly reliable index of the relative degree of maturity of chinook salmon.

Without attempting to discuss further the method used for determining relative maturity, a tabular summary will be given of the results obtained by the study of the ten collections which have formed the basis for this report. It is hoped that further study will increase the accuracy of the results, and it seems probable that some of the percentages given in the table may be somewhat modified by additional investigations. It is believed, however, that the results as given here are fairly reliable. In preparing the table care has been taken to include doubtful cases always with the more mature of the two groups to which they might be assigned. This has been done in order not to exaggerate the degree of immaturity exhibited by any of the various collections.

TABLE I.

Composition as to age groups and relative maturity of a collection of 165 females taken by troll off the mouth of the Columbia River, May 8 to 10, 1919.

Age groups	Number of specimens and per cent which would mature during:						Total	
	Year taken		Following year		Second year following			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Ocean nuclei—								
In 2d year-----					19	100	19	11.5
In 3d year-----	2	2	100	98			102	61.8
In 4th year-----	18	100					18	10.9
In 5th year-----	1	100					1	.6
Stream nuclei—								
In 3d year-----			18	100			18	10.9
In 4th year-----	2	100					2	1.2
In 5th year-----	3	100					3	1.8
In 6th year-----	2	100					2	1.2
Totals-----	23	17	118	71.5	19	11.5	165	-----

TABLE II.

Composition as to age groups and relative maturity of a collection of 68 females taken by troll off the mouth of the Columbia River, June 4, 1918.

Age groups	Number of specimens and per cent which would mature during:						Total	
	Year taken		Following year		Second year following			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Ocean nuclei—								
In 2d year—					18	100	18	26.5
In 3d year—			32	97	1	3	33	48.5
In 4th year—			1	100			1	1.5
In 5th year—	1	100					1	1.5
Stream nuclei—								
In 3d year—			10	100			10	14.7
In 4th year—	2	50	2	50			4	5.8
In 5th year—			1	100			1	1.5
Totals—	3	4	46	68	19	28	68	

TABLE III.

Composition as to age groups and relative maturity of a collection of 48 females taken by seines and wheels near Warrendale, Oregon, June 16 and 17, 1919.

Age groups	Number of specimens and per cent which would mature during:						Total	
	Year taken		Following year		Second year following			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Ocean nuclei—								
In 4th year.....	1	100					1	2
In 5th year.....	10	100					10	21
Stream nuclei—								
In 4th year.....	17	100					17	35
In 5th year.....	20	100					20	42
Totals.....	48	100					48	

TABLE IV.

Composition as to age groups and relative maturity of a collection of 51 females taken by traps in Baker Bay, Columbia River, July 3, 1919.

Age groups	Number of specimens and per cent which would mature during:						Total	
	Year taken		Following year		Second year following			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Ocean nuclei—								
In 3d year.....	1	100					1	2
In 4th year.....	24	100					24	47
In 5th year.....	17	100					17	33
In 6th year.....	3	100					3	6
Stream nuclei—								
In 3d year.....			1	100			1	2
In 4th year.....	4	100					4	8
In 5th year.....	1	100					1	2
Totals.....	50	98	1	2			51	

TABLE V.

Composition as to age groups and relative maturity of a collection of 41 females taken by beach seines on Sand Island, Columbia River, July 7, 1919.

Age groups	Number of specimens and per cent which would mature during:						Total	
	Year taken		Following year		Second year following			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Ocean nuclei—								
In 2d year.....					5	100	5	12.4
In 3d year.....	1	50	1	50			2	4.8
In 4th year.....	20	100					20	48.8
In 5th year.....	8	100					8	19.5
Stream nuclei—								
In 3d year.....					4	100	4	9.7
In 4th year.....	1	100					1	2.4
In 5th year.....	1	100					1	2.4
Totals.....	31	76	1	2	9	22	41	

TABLE VI.

Composition as to age groups and relative maturity of a collection of 102 females taken by troll off the mouth of the Columbia River, August and September, 1918.

Age groups	Number of specimens and per cent which would mature during:						Total	
	Year taken		Following year		Second year following			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Ocean nuclei—								
In 2d year.....			1	20			5	5
In 3d year.....	21	84	4	16	4	80	25	24.5
In 4th year.....	19	95	1	5			20	19.5
In 5th year.....	19	100					19	18.5
Stream nuclei—								
In 3d year.....			2	100			2	2
In 4th year.....	3	100					3	3
In 5th year.....	27	100					27	26.5
In 6th year.....	1	100					1	1
Totals.....	90	88.3	8	7.8	4	3.9	102	

TABLE VII.

Composition as to age groups and relative maturity of a collection of 95 females taken by troll off the mouth of the Columbia River, August 13, 1919.

Age groups	Number of specimens and per cent which would mature during:						Total	
	Year taken		Following year		Second year following			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Ocean nuclei—								
In 2d year-----			1	50	1	50	2	2.1
In 3d year-----	9	60	6	40			15	15.8
In 4th year-----	68	95.5	3	4.5			66	69.5
In 5th year-----	4	100					4	4.2
Stream nuclei—								
In 3d year-----			1	100			1	1.1
In 4th year-----	6	85.7	1	14.3			7	7.3
Totals-----	82	86	12	13	1	1	95	

TABLE VIII.

Composition as to age groups and relative maturity of a collection of 63 females taken by troll in Monterey Bay, June 19 to 21, 1918.

Age groups	Number of specimens and per cent which would mature during:						Total	
	Year taken		Following year		Second year following			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Ocean nuclei—								
In 2d year-----			1	50	1	50	2	3.2
In 3d year-----	15	29	36	71			51	81
In 4th year-----	6	100					6	9.5
Stream nuclei—								
In 3d year-----			1	100			1	1.6
In 4th year-----	3	100					3	4.7
Totals-----	24	38	38	60	1	2	63	-----

TABLE IX.

Composition as to relative maturity of a collection of 144 females taken by troll in Monterey Bay, California, June 29, 1915. Determined from a study of the eggs alone.

Age groups	Number of specimens and per cent which would mature during:		
	Year taken	Following year	Second year following
Number	108	35	1
Per cent	75	24.3	.7

TABLE X.

Composition as to relative maturity of a collection of 64 females taken by troll near Drake's Bay and Fort Bragg, California, July and August, 1918. Determined from a study of the eggs only.

Age groups	Number of specimens and per cent which would mature during:		
	Year taken	Following year	Second year following
Number	43	18	3
Per cent	67	28	5

From the data contained in these tables the following generalizations may be made:

1. The fish taken in the ocean off the mouth of the Columbia River contain, in the spring and early summer, approximately 70 per cent of individuals which will not become sexually mature for one or two years.

2. By the middle of August this condition has changed so that nearly 90 per cent are fish which will soon enter the river for the purpose of spawning. The rate at which this change takes place and the time at which it occurs have not yet been determined, but will be taken up in the later report.

3. A comparatively small percentage of the fish found just within the mouth of the Columbia River are immature. It should be mentioned in this connection that it is only occasionally when unusual tidal conditions obtain that any immature fish are taken inside the mouth of the stream.

4. The fish taken by troll in Monterey Bay in June contain a considerable proportion of immature individuals. The data obtained in 1918 are most reliable, and indicate that only about 40 per cent of the fish taken would have spawned during the same year. The data for 1915 indicates that 75 per cent were mature, but selection may well have taken place in making this collection which, as noted above, consists of egg samples only.

5. The fish taken near Drake's Bay and Fort Bragg in July and August, 1918, contain approximately 30 per cent of immature fish. It is of interest to note that this is an approach to the conditions found off the mouth of the Columbia River in August and suggests that the composition of all the schools found near the coast changes materially during the summer season.

GEAR USED FOR SALMON TROLLING IN CALIFORNIA IN 1920.

By W. L. SCOFIELD.

Object. These notes, by no means complete, are intended to be a rough record of the type of gear used in open sea salmon trolling in California at present (1920) as a partial supplement to the system of triplicate receipts for statistics of catch recently installed by the Fish and Game Commission. The fact that gear and methods have changed decidedly in the past few years and no doubt will continue to change makes this summary necessary.

The notes deal chiefly with *gear* used. Such subjects as history of trolling, points at which trolling is practiced and its extent, location for trolling in a given local area, prospecting for schools, and deep vs. shallow fishing, although most important, are omitted or merely touched upon here.

Variation in Methods. There is considerable variation in methods and equipment, with great divergence of opinion on most of the subjects taken up in these notes. While the industry was new this was an advantage, as established custom did not limit experimenting,

but the results of the experimenting were not kept in definite form to be used, each fisherman satisfying only his own opinion without giving others the benefit. As a result there has been much duplication and improvement has been slower than need be. As fishing practice is now more established future improvements will result from more accurate experimenting with definitely recorded results.

Location for Trolling. Most of the fishermen move from one region to another following the salmon runs. The Monterey season opens first (January or February) and the local Monterey fleet is doubled or trebled by boats that go down from northern points, chiefly from San Francisco. Toward the end of the Monterey season (June) these boats begin leaving for San Francisco. They either fish for a time out of San Francisco or Point Reyes or go on up the coast to Bodega Bay, Fort Bragg and Shelter Cove. About August they begin returning to San Francisco. This year several boats, after completing the season at Shelter Cove, went farther north, some bound for Astoria.

In a given region the greatest and most difficult single factor in success is picking the good place to troll. Some days the big catches are made near shore in shallow water. At other times the trolling is best far out in deep water. In Monterey a quite generally believed theory is that schools come up from the south, enter the bay to feed for a few days and then leave. Other fishermen cite cases where the schools come from the north. Some fishermen prospect far out in order to locate entering schools. Cases are known where such a school has been fished day after day on its way to Monterey and while in the bay. Other schools have been followed far up the coast.

In the choice of location most fishermen merely follow some "hunch" and go it blind, keeping an eye on the other boats till they see someone landing fish and then go to that locality. When a large school is biting the whole fleet is often bunched in a small area. A plan often followed at Fort Bragg is to start trolling near shore with a shallow set and work farther out, gradually increasing the depth of line while prospecting for a school. Undoubtedly the successful fishermen have gathered a great amount of knowledge from experience but these "trade secrets" are not discussed freely. A knowledge of the habits of sardines, anchovies and squid is undoubtedly a help to some fishermen. Little is known of the effects of local currents carrying food and the consequent behavior of salmon.

Deep vs. Shallow Fishing. The most successful fishermen experiment at different depths and prospect to locate schools. It is a common saying that small Chinooks are caught more often in shallow water near shore. Silver salmon are said to be caught near the surface. There are, however, many exceptions. Some days when the fish are feeding actively the large Chinooks are caught near the surface. A common method of prospecting is to set one line with two to five fathoms of main line out (above leads) and the other line set with 10 to 20 fathoms out. Good catches are made at a great variety of depths on different days and practically nothing is definitely known of the reasons. Whether or not different schools feed differently is not known. Whether or not the weather affects the depth is not known, but some fishermen work on the theory that deep fishing is best on a clear bright day and that the set should be shallow for

cloudy dark days. This suggests the possibility of plankton sinking to greater depths on clear days, small fish following the plankton and salmon following the small fish. Practically nothing is known of the effect on salmon of different water temperatures. Color of the water is believed by fishermen to be important. Clear water is believed to be poor for salmon fishing and at such times deep fishing is said to be more successful than shallow. Dark, murky or even reddish water is thought to be best for salmon catches and can be fished nearer the surface. The "red water" of deep color sometimes seen along shore is not good for trolling.

Boats. The type of boat most used is a clipper bow boat of wide flare forward and a pointed compromise stern. Often there is a small cockpit near the tiller and a high narrow house open at the back that is little more than a wind and spray screen when standing at the wheel near the engine. As the change from sail to power fishing has been recent there are a number of converted sailboats in use, especially the small Mediterranean type of boat that formerly used a latine sail. There are also a number of converted pleasure boats of a great variety of types. The pointed stern is usually favored rather than a rounding fantail stern because with the narrow stern it is easier to haul a fish up alongside on either side while still operating the tiller. The first troll boats were square sterns. Then the rounding or fantails were found to be better suited to landing the fish as there were no corners for the line to catch on and the stern is low in the water. The low stern was not so good when the boats began going out farther in rough water. Now that two-line fishing is almost universal the bluntly pointed compromise stern is used most.

As fish are becoming less plentiful the tendency has been to use increasingly larger boats capable of going farther out with comfort. The clipper bow type ranges in size from 20 to 40 feet over all with 30 feet as about the average size. The few 40 foot boats usually fish four poles.

The older boats have only a small hatch forward to allow a man to crawl below deck. A recent tendency toward comfort has been to raise the forward deck to allow more room below and a number of boats now have a low house extending forward with portholes to admit light and air. This could be more general since the forward deck is not used except for stowing the anchor and chain.

Nearly all boats carry but one fisherman. The larger boats fishing four lines sometimes carry two men, one handling the starboard lines and the other the port, but frequently one man operates the boat and handles four lines. The catch of a large boat is usually not equal to the catches of two smaller two-line boats, so experienced fishermen prefer to fish alone and not divide profits. Many of the one-man boats are decked over the stern and this is much more dangerous for the fisherman than having a small cockpit. The gunwale is only three or four inches high, the deck is wet, the boat rolls in a rough sea and while landing a fish the fisherman often has to keep one leg on the tiller so that his chances of going overboard seem fairly good, and once overboard with the engine running and his rubber boots too heavy for swimming, his only chance is to be picked up by some other boat.

Engines. Boat engines are of one and two cylinders, the majority being one-cylinder. The two-cylinder engines are nearly all 12 horsepower. The one-cylinder engines develop 6 or 8 horsepower capable of giving a boat speed of about seven miles per hour. The Hicks engine is the most popular engine for trolling boats, but there are many Standard engines in use. In all there are about 20 different makes used, including the Ford automobile engine. Eastern engines built for pleasure boats are also used, such as the Buffalo and Scrips. Most of the boats under 30 feet long have a one-cylinder and boats over 30 feet have a two-cylinder engine.

Speed of Boats. When trolling the engine is choked down till the boat travels at from 2 to 4 miles per hour, 2½ to 3 miles is usually preferred. The speed is greater when fishing near the surface. The deeper the lines the slower the boat is run. This is partially based on the theory that the fish on the surface are more active in taking bait or spoon and that fish deeper are more easily tempted by an object moving more slowly. A greater influence in slowing down for deep fishing is the fact that the line may be given a deeper set with the addition of but few extra weights. The slower the speed the deeper the set for a given amount of leads and hauling in a deep set, heavily weighted line on a rapidly moving boat with the resulting water drag on the line is back breaking work, so that the theory of deep fish being more sluggish fits in nicely. The speed is greater when fishing spoons rather than bait is used. Most spoons do not have the proper motion (spinning or side to side weaving) when the boat is run as slowly as is customary in bait fishing.

Poles. Poles are made from young peeled saplings, seasoned and trimmed down, usually of pine, eucalyptus or Douglas fir. Many bamboo poles are used, a single large pole or three small diameter poles lashed together. Often a short section of bamboo is lashed to the pole near the tip as a reinforcement at the point where a break is most apt to occur.

For small boats a general rule is to have the length of pole equal to the length of the boat as this is believed to give better balance. Boats using four poles have two short poles forward and two very long poles aft. Twenty-five feet is about the average length of pole.

Placing of Poles. Since there are many different styles of boats used there is great variation in the arrangement and position of the poles on the boat, each fisherman following his own ideas to best fit the deck plan of his boat. In some cases the poles are far forward, in most cases amidships and in some cases far aft. When the boat is small and of narrow beam the poles are usually crossed so that the base of the starboard pole rests in the scuppers of the port gunwale. This arrangement does not require a mast. In large boats the poles are used with a short mast, the base of the pole fitting into a socket or bolted at the foot of the mast. Since the distance from the mast foot to the gunwale is short, the pole when under strain has a great leverage. The strain is relieved by guy lines run from the bows. When very long poles are used even on larger boats they are sometimes crossed thus giving a longer pole base support within the boat.

Pole Supports. In all cases the pole has a vertical support on the gunwale to give the tip the necessary elevation. These supports may be simply two boards nailed together like a letter X, or a single board

with a U notch cut in the upper end to receive the pole. Some have a notch cut to curve aft so that the pole jams in and is held down tight when the boat rolls violently. Other supports are made by bending the end of an iron rod into a U-shaped receiver for the pole.

Stowing Poles. When not trolling the poles are seldom left spread because of the danger of being broken. In some cases they are laid on deck along the gunwales, sometimes lashed to the top of the house with their bases in the bows, often drawn up vertically beside the short mast, fitting in notches at the mast head. Sometimes the pole base is hinged so that the poles may be lowered aft against the top of the house. In a few cases the mast is set on a hinged base so that mast and poles may be lowered at night or to pass under a bridge.

Pole Line. In trolling the main line is not attached to the pole directly. There is a short large-sized line or "pole line" with one end tied to the pole tip and the other end provided with a snap hook which is snapped into the main line at any desired point. The upper portion of the main line then hangs loose from the snap to the stern of the boat and provides a very convenient method of pulling in the line, since the pole line and snap are from 15 to 25 feet out from the stern while trolling.

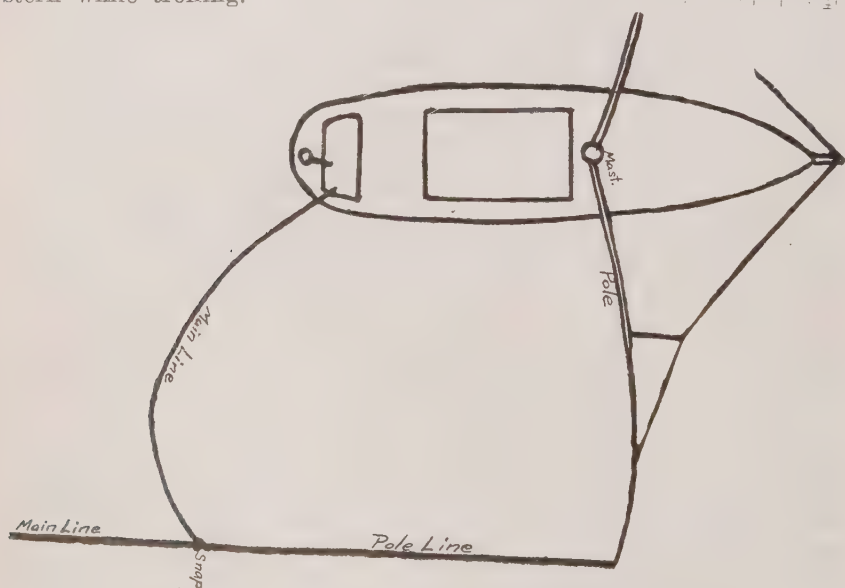


FIG. 13. Diagram showing gear arrangement on a salmon boat.

The pole line is a few feet longer than the pole so that it may be unsnapped from the main line and snapped into a cord loop on the gunwale near the stern when the main line is being hauled or when the poles are stowed against the mast. This arrangement easily allows the main line to be fished at any desired depth. The snap may be used in the loop of any lead or in loops tied in the main line two and one-half or five fathoms apart. The main line loop is made by doubling back the line and tying a simple hard knot leaving two or three inches free to form the small loop, just enough to receive the snap conveniently.

Plan of Rig. Although there is great variation in details of the arrangement of weights and line the "taper line" is almost universally used. The taper line is heavy (large) at the top, tapering in size toward the bottom. The size of the leads also tapers off, with the lightest at the bottom. The object of the tapering size of line is largely to avoid loss of the whole line when the lower hooks catch on rocks.

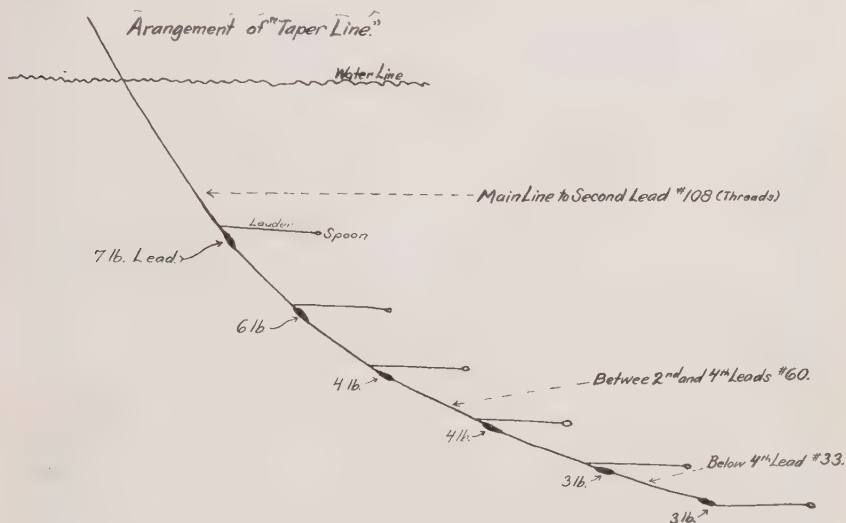


FIG. 14. Diagram showing arrangement of a taper line.

The strain breaks the line only part way up so that only the bottom portion is lost. Also the decreasing size of line and leads decreases the water drag on the lower portion where the drag is hardest. The tapering size of leads toward the bottom has the effect of allowing the far end of the line to trail out more nearly approaching the horizontal, thus bringing the bottom three or four hooks within a more limited vertical range. This plan of rig allows great variation in depth of fishing without changing the rig. When it is desired to fish near the surface the bottom three leads and leaders may be paid out, the lightness of rig being an advantage. To increase the depth, one or two more leaders are paid out. When all leaders are out the depth is increased by paying out more main line (up to 10 fathoms. Over 10 fathoms greater depth is best obtained by adding more lead).

When a school is located the depth of the school may be determined by noticing which hook is taken and the taper line is then lowered till the second or third hook from the bottom is at the determined depth. Thus the bottom four hooks are brought close to the desired depth.

In taper lines the size of the line is tapered by three or often four changes in size. There is no uniform plan of taper lines approved more than another. An arrangement often used is a No. 108 main line to the second lead from the top, No. 60 line between the third and fourth leads and No. 33 or No. 30 below the fourth lead. (See paragraph on Line Sizes.)

Another plan of rig rarely used is very different from the taper line in that the object is to have the hooks fall at approximately equal distances apart vertically instead of within a limited vertical range. In this plan a uniformly heavy line is used (No. 144 for example) with the leads arranged just the opposite to the taper-line plan, that is, the lighter on the top and the heaviest at the bottom. With this arrangement the line is more nearly vertical and can be given a deeper set than the taper line. This line offers the greatest resistance in the water and if snagged on the bottom the whole line, with all the hooks and leads, may be lost.

Number of Lines Used. The number of lines used from a single boat varies from one to four with two as the usual number. Early in open sea trolling one line was used but is seldom seen now. Nearly all boats use two poles with a line from the tip of each pole. An occasional boat fishes a third line directly astern but this line is lightly weighted to keep near the surface. An occasional boat fishes four lines from two extra long poles, in which case the two additional lines are attached about midway out the pole. Several of the largest boats fish four lines from four poles, two short poles placed well forward and two long poles placed about at the boat's greatest beam in order that these lines may be as far out as possible to avoid tangling with the forward lines.

Whatever the arrangement of lines, care is used to keep the lines separated to avoid tangling while set or while hauling in. The fisherman stands in the cockpit or on the deck far aft so that he may control the tiller with his foot while hauling in. In good weather the tiller is often disregarded but in a strong wind or current a fairly straight course is kept because a sharp turn is apt to tangle lines.

Number of Hooks per Line. The number of hooks used on each line varies from one to nine but five or six is the usual number. Most of the lines are rigged with six hooks (or spoons). Lines rigged with nine hooks are sometimes used in prospecting but when fish are located and fishing is begun the number is reduced by removing leaders and leads. A two-hook line is occasionally used in surface fishing.

Line Sizes. The line commonly used is a cotton seine-line which is made in three grades, soft, medium and hard laid. For trolling the hard laid line is used. Practically all line used is made up of three strands twisted, each strand being made up of a number of threads. A four strand line is rarely used. The sizes of line are designated by a number which represents the total number of threads. For example No. 30 is a line of 10 threads to each of the three strands. Up to No. 36 the sizes are numbered at the addition of each three threads, as No. 21, No. 24, No. 27, etc. From 36 to 60 the addition of six threads is used in numbering, as No. 36, No. 42, No. 48, No. 54, No. 60. Above 60 the size numbers designate the addition of twelve threads as No. 60, No. 72, No. 84, No. 96, No. 108, No. 120, No. 132, No. 144, No. 156. The sizes of line commonly used range from No. 21 to No. 156.

The main line varies greatly in size according to the arrangement of leads. With a deepset heavy weight line No. 132, No. 144 or No. 156 is used. The upper portion (above the leads) of a "Taper Line"

varies from No. 84 to No. 156 but sizes from No. 108 to No. 144 are more frequently used.

Leaders are No. 21 to No. 42 but Nos. 27, 30, 33 and 36 are the usual sizes, No. 30 being used most.

The bottom portion of the taper line is usually the same or more frequently one size larger than the leaders. Some taper lines have a different sized line between each two leads, as for example from the top downward, No. 144, No. 108, No. 84, No. 60, No. 48, No. 36. Light taper lines generally use only three sizes as No. 108 to the second lead from the top, No. 60 between the second and fourth leads and No. 33 below the fourth lead. A more frequent arrangement of sizes for taper lines is four sizes—No. 144 to the first (top) lead, No. 108 from the first to third lead, No. 60 from third to fifth lead and No. 33 below the fifth lead.

The size of line makes no apparent difference in the catch. Evidently the fish are no more wary of a large line than of a small. The line must be strong enough to hold the strain of a fighting salmon added to the resistance of line and leads in the water. Beyond this the individual preference of the fisherman determines the size. The very large lines are better in that they do not cut the hands so much while hauling in but they offer a decidedly greater resistance in the water and require harder pulling and more lead.

Color of Lines. Opinions are conflicting as to the best color for lines. Some fishermen use the white untreated line as it comes from the store. Most fishermen tan the lines brown, more for the purpose of preserving than making the line invisible. Some fishermen dye the lines green, believing that this color decreases visibility and insures better catches. Blue line is sometimes used. Many fishermen believe that color makes no difference in the catch.

Depth of Lines. On a two-pole boat the poles are usually elevated so that the line enters the water at a point about opposite the boat's stern. The line usually enters the water at an angle to the water surface of 30 to 45 degrees. Water resistance then curves the line astern. The taper line curves astern till the bottom of the line is nearly horizontal. The actual depth reached by different types of line is not known and makes no particular difference to the fisherman except in avoiding snagging rocks. He is chiefly concerned with the relative depth for his plan of rig, that is, how much line to pay out to bring his hooks to the depth where fish are biting best that day. A six-hook taper line with six fathoms between leaders means 30 fathoms of line. This line is fished with from 0 to 40 fathoms of line (above top lead) so that a total of 70 fathoms of line may be out in extreme cases but the greatest actual depth reached is probably not over 30 fathoms assuming the average angle of the line to be about 25 degrees to the water surface. This is an extreme case since 25 fathoms of main line (above leads) is generally the greatest amount used and 5 to 10 fathoms are most frequently used. With 10 fathoms out (40 fathoms total) the usual depth reached is probably 20 fathoms.

With the ordinary arrangement, a total of 27 to 30 pounds of lead and 10 fathoms of main line (above leads), the paying out of more main line does not materially increase the depth because the water resistance to the large line merely trails the whole gear astern. A greater

depth is then obtained by adding more lead rather than more main line. The size of the main line is an important factor in depth because a given weight will take a small line much deeper than a large line.

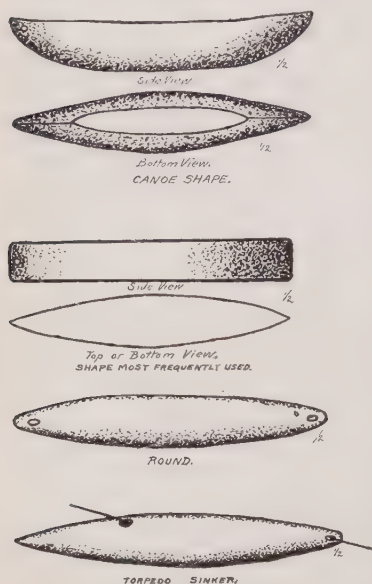


FIG. 15. Types of lead sinkers.

Leads. Although suitable lead weights may be purchased, they are usually home-made, an easy method being to bend two pieces of strap iron into a rough boat shape pointed at both ends and pour in the molten lead, using a sheet of paper over sand for bottom. Some leads are made rounded and pointed at each end. Others are quite carefully moulded in boat shape with the bottom tapered back and smaller than the top. This canoe shape is intended to ride upright with the least possible resistance to the water but it fails of its purpose because it is supported at an angle by the main line and its points of attachment, being near the top, allows the bottom to shear off to one side (skate). The result is that the weight meets the water broadside instead of bow on as intended. The lead cast in a rough boat shape with straight bow and stern with top and bottom the same size and shape is the

lead most used because it rides straight without skating, is the simplest and easiest to make and does not roll on the deck. It is generally agreed that the best possible shape is the round lead (cigar shape) elongated and pointed at each end. This lead offers the least possible resistance to the water and therefore greater depth can be had with less weight, but it has two disadvantages, the greatest of which is that it rolls on the deck and is a great inconvenience in tangling up the lines when on deck. It is also expensive to buy or, if home-made, very difficult to mold.

Boats coming down to the California coast from the north (especially the Columbia River boats) frequently carry much larger leads, a common shape being a round lead of large diameter, slightly elongated with bluntly rounded ends, the lead being more the shape of a keg than a cigar. This same general shape is sometimes used slightly flattened but this shape usually sheers off so that the lead meets the water broadside. Another lead occasionally seen is a very large round lead pointed at one end and perfectly flat at the other, giving the shape of an old style beehive.

Another type of lead is credited with obtaining the greatest depth for a given weight. This is the "torpedo sinker," cigar-shaped but the forward attachment to the line instead of being at the pointed end is about one-third of the way back on one side (top) of the lead. This method of hanging allows the forward point to dig downward into the water with the tendency to deepen the whole line. The objections to this lead, aside from the difficulty of rigging it, are that the free point tangles the line on deck, the lead rolls on deck and when in

the water it gathers up floating seaweed in the angle formed by the line and the free point of the sinker.

The weight of a single lead in most cases varies from 2 to 10 pounds the usual weights being 3, 4, 5, 6, and 7 pounds. Occasionally a metal ring is cast in the lead for convenience in attaching the line, but this is apt to cut the line. The usual method is to bore a hole through the end of the lead and tie in a short piece of heavy line leaving a long loop or "strap" into which the main line may be tied with a bowline. An occasional fisherman rigs his leads with a swivel snap at each end so that the lead may be easily exchanged for a lead of a different size. This would be particularly convenient in prospecting and experimental fishing.

Amount of Lead. There is little uniformity in the total amount of lead used, each fisherman having his own ideas. Lines carry from 4 to 40 pounds of lead, 18 to 35 pounds being the most general range for taper lines of 6 hooks, with 27 pounds as the weight most frequently used. For surface fishing as little as four pounds of lead (two 2-pound leads) is sometimes used on a two-hook line.

In taper lines no arrangement can be considered typical but the weight is often distributed somewhat as follows from top to bottom—7, 7, 6, 5, 5, 3, totaling 33 pounds. Fishermen preferring less weight have some such arrangement as 7, 6, 4, 4, 3, 3, totaling 27 pounds. A frequently used total weight for a six-hook taper line is 29 pounds arranged 8, 6, 5, 4, 3, 3, pounds. Many of the fishermen that fish five hooks use as much or more lead than on the six-hook lines. The arrangement on such a five-hook line is frequently 10, 8, 4, 5, 3, totaling 30 pounds. Heavy deep set lines, though rarely used, are arranged from top to bottom somewhat as follows—4, 5, 6, 7, 7, 8, totaling 37 pounds.

On any one line the amount of lead used is not fixed but varies from day to day and may be changed several times during a day.

Leaders. Each hook (or spoon) is attached to the main line by a "leader" or short line 3 to 6 fathoms long. The weighted main line extends downward at an angle allowing the unweighted leader to trail out behind horizontally.

The length of the leader depends on the distance between leaders on the main line, the leaders being a little shorter than the distance between leaders. This is to avoid tangling in case the boat stops and the lines hang straight down, and also while hauling in the line. The distances used most commonly are 6 fathoms between leaders with a $5\frac{1}{2}$ -fathom leader. Another plan of rig frequently used is $3\frac{1}{2}$ -fathom leaders placed 4 fathoms apart. This rig with 4 fathoms between leaders allows more hooks within a limited vertical range when a school is located and found to be biting at a fairly uniform depth.

Attachment of Leader to Main Line. Leaders are attached to the main line from one to two feet above the lead sinkers, the usual distance being 18 to 20 inches. When ocean trolling for salmon started on the coast, it was the practice to attach the leader to the loop at the upper end of the lead but it was found that a hooked fish in fighting would tear loose from the hook because the heavy lead supported by the taut line offered too much resistance to the sudden jerk. For this reason the leader is a little above the lead so

that the taut main line will give more spring to the sudden jerking of the fish. The bottom leader is usually attached to the bottom of the last lead in taper lines and in order to offer a less solid resistance to the fighting fish a light rather than a heavy lead is used at the bottom, a three-pound lead being most frequently used.

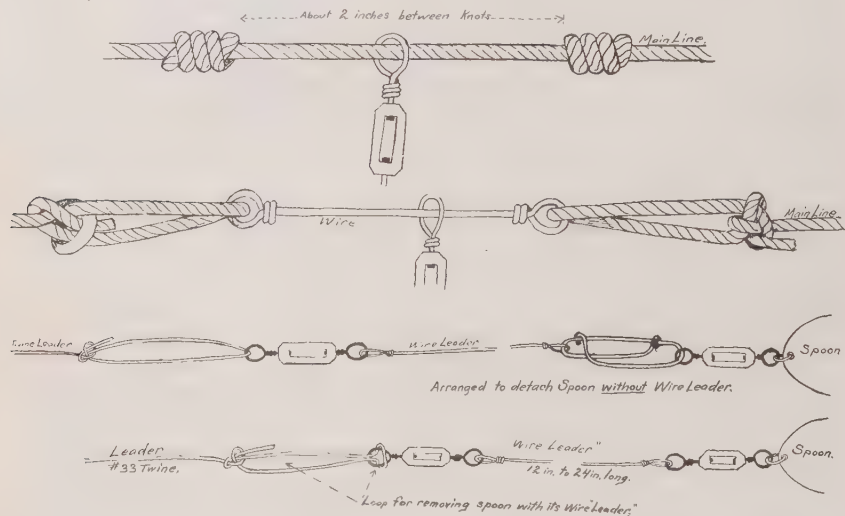


FIG. 16. Diagram showing method of attachment of leader to line.

The usual method of attaching the leader is to tie a "running knot" in the main line which leaves the line straight as if threaded through three or four wraps of itself. The name "running knot" refers to the fact that the line runs straight through but the knot itself is perfectly solid. The line is then threaded through one ring of a swivel and another running knot tied at from two to four inches from the first. The leader is then tied into the other ring of the swivel with a bowline. The swivel protects the main line from being twisted by the leader and the distance between knots allows some play for the leader without crawling up or slipping down. The wire ring of the swivel is apt to wear on the lower knot and to avoid this a short wire section is sometimes inserted in the main line. This wire is about two inches long, threads through a swivel ring and looped at each end with the ends wrapped into a shoulder to keep the swivel. The main line is tied with a bowline into each loop of this wire section. By this arrangement the swivel plays on wire but the strain of the whole line now falls on the loop of the bowline bearing on the wire loop and this is apt to cut under a heavy strain.

Bait vs. Spoons. There is the greatest divergence of opinion among fishermen on the relative merits of spoon and bait. One fisherman will remain in because no fresh bait is available, another will use nothing but spoons, another insists on having both, while most fishermen change from one to the other at different times in the season. At Fort Bragg, for instance, there is a general belief that the spoons are more successful during the early part of the season and that bait is better for the latter part of the season. The majority of fishermen

prefer fresh bait, but when it is difficult to get or expensive, they use spoons. At Monterey most of the Japanese prefer spoons throughout the season and most of the white fishermen prefer bait at all times even when it has to be purchased at from 75 cents to \$2 a bucketful.

A few half-hearted experiments have been tried by using one line baited and the other rigged with spoons, but such trials have been brief and the findings merely personal opinion rather than actual figures of the catch.

A fresh sardine about seven inches long is almost universally preferred as bait. Squid tear off the hook. Anchovies are too small. Salted and formalin-preserved sardines are occasionally used but without much success, generally attributed to the loss of the bright shining appearance of the fresh fish.

Spoons. A variety of spoons are used, no one being a universal favorite. A number of fishermen prefer the hook attached solidly to the spoon (as in the Dubrow) because they believe that the salmon is more apt to be hooked, claiming that the swinging hook is apt to be brushed aside. Some fishermen prefer the Wilson spoon with a free swinging hook that is attached about one-third of the way up the spoon, because they believe this arrangement is more apt to hook the fish. However, most makes of spoons have the hook swinging from the lower end of the spoon, as in the McMahon, Diamond and Kewell-Stewart.

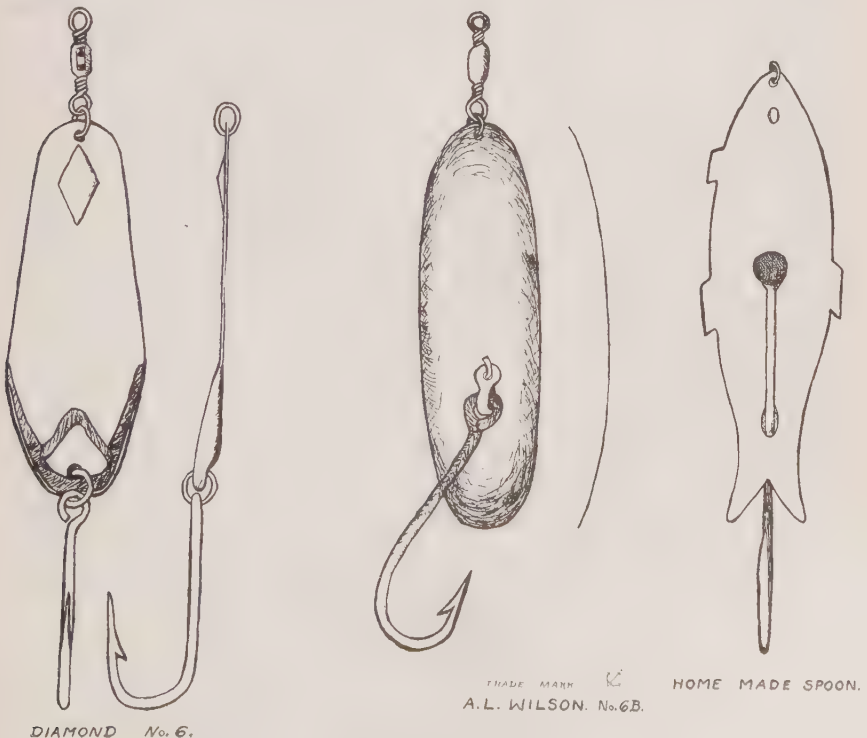


FIG. 17. Various types of salmon spoons.

The chief consideration in any spoon is its shape to govern its motion in the water. Although the spoons are of polished silver plating or brass to attract salmon by their shining, it is their action in the water resembling a swimming sardine that is most important. Some spoons are designed to spin in the water with a wriggling motion. Most spoons zigzag while constantly tipping from side to side so that the broad shining surface is displayed as often as possible. The Dubrow spoon for instance is curved to give a zigzag motion when trolled slowly and the tails are curved propeller fashion to spin the spoon when moving more rapidly. The McMahon spoon was the most popular at Fort Bragg during the 1920 season. This spoon tips rapidly from side to side when trolled and follows a fairly straight course. This tipping is continued even when the speed is greatly slowed down and the McMahon's popularity is largely due to the fact that it can be trolled slower than most other spoons. The Stewart and Wilson spoons tip less from side to side but follow a more zigzag course. Fishermen who have used Dubrow, Wilson, Stewart and McMahon spoons almost equally throughout a season claim to have had equal success with all four spoons but favor the McMahon because it is successful at a slower speed. There are quite a few home-made spoons in use, the spoon being cut from a sheet of plated brass. A successful home-made spoon is made on the Dubrow plan by riveting in a No. 11 or No. 12 long-shanked eye hook. Home-made spoons of the Kewell-Stewart type are most frequently used and are more easily made than the other types. The Wilson type is also seen frequently and is comparatively easy to make.

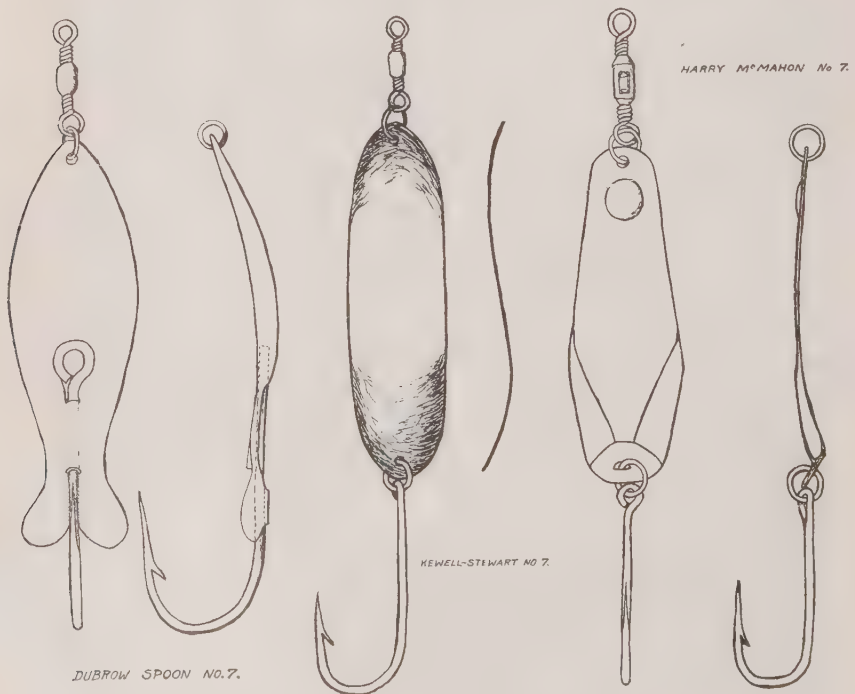


FIG. 18. Various types of salmon spoons.

The size of the spoon does not vary greatly, No. 6 and No. 7 being the favorites. McMahon No. 7 is used most although some No. 6 are used. The No. 6 Dubrow is used more than the No. 7. In Kewell-Stewart spoons No. 7 is used most. In Diamond spoons, No. 6 is preferred.

Bait Hooks. When fresh bait is used (sardines almost universally) the hook is passed twice through the head (through the eyes) of the sardine so that a couple of firm hitches are made on the head by the line. The sardine is then bent to one side at about the same curve as that of the hook and the hook passed through the body longitudinally, in at the mouth and the curve of the hook out at the anal opening leaving the shank of the hook inside the body. Because of this preferred method of attaching the bait a *long* shanked hook with a knob head is used. The knob, much like the head of a finishing nail, is the diameter of the shank and is formed by the shank diameter being reduced just below the knob.

Many of the hooks are made in Norway, especially the Kirby hooks, which have a slant to one side in addition to the curve so that the point sets at an angle to the shank. Most fishermen prefer a straight hook without the side slant and the Kirby hooks are often straightened in a vise before using. In all hooks the point is considered to bend in too sharply toward the shank and most fishermen bend the points outward a little before using.

When using a short-shanked hook the bait is more apt to be swallowed by the salmon and the hook is then difficult to extract and the leader is more apt to be cut on the teeth of the fish. A hook with a large diameter at the curve is preferred because it is less apt to tear out of the salmon's mouth.

The sizes used range from No. 9 (small) to No. 13 (large), sizes 11, 12, and 13 being used most. There is a quite general belief among fishermen that the first of the season runs small fish and the end of the season large fish. Some fishermen therefore use No. 11 sized hooks at the first of the season and No. 13 toward the end of the season. No. 12 is the most popular size for bait hooks.

Hook and Spoon Leaders. A No. 33 cotton leader attached to the hook knob would be too large for convenient threading through the bait. For this reason a short hook-leader is used, a line of Irish linen



FIG. 19. Kirby hook No. 12. Natural size.

being preferred as it is small, light, pliable, and strong. The most popular make is the Cuttyhunk, a three-strand linen bass line. The sizes used range from 24 to 60 but the sizes 27 and 42 are used most although all sizes between are occasionally used. For hook-leaders a No. 6 or No. 7 Irish flax salmon thread doubled is sometimes used. Other fishermen use No. 7 airplane thread doubled and twisted. Such thread is attached to the hook by taking a piece four or five feet long, making a double half or clove hitch over the hook knob in the center of the thread and twisting the ends.

The length of the hook leader varies from one and one-half to three feet, two or two and one-half being preferred by most fishermen.

A swivel is used between the hook-leader and main cotton leader, using a bowline at each end of the swivel. Some fishermen think that the loop of the bowline over the Cuttyhunk leader cuts in and weakens the leader, so they double back the end and tie a plain hard knot in the doubled Cuttyhunk. This may be attached to the swivel end by inserting the loop through the swivel eye and threading the hook and leader through the free end of the loop, making a reef hitch. This hitch also has the advantage that the hook and its leader may be removed by unthreading without untying any knots. This same hitch is frequently used at the lower end of the main leader where it attaches to the swivel, especially when a wire spoon leader is used. The main leader is less apt to cut on the swivel eye but the chief advantage is that the swivel, wire leader and spoon may be easily removed without untying any knots.

When spoons are used a Cuttyhunk spoon leader is sometimes used but a short wire leader is usually preferred because the linen thread is apt to be cut on the fishes' teeth and especially when a shark is hooked or is attacking the hooked salmon. For this purpose a two or three foot brass or plated brass wire is generally used, belt lacing wire being the favorite as it is pliable and very strong, but it can be broken if the fish in thrashing about gets a kink in the wire. To avoid this some fishermen use piano wire since it is exceedingly strong and so stiff that it is not kinked and broken, but its stiffness makes it much more inconvenient to handle, especially in removing spoons. In order to overcome this inconvenience some fishermen use some form of home-made stiff wire snap or fastener to free the spoon. This snap is sometimes inserted just below the swivel so that the wire leader is removed with the spoon, or just above the swivel of the spoon so that the wire leader remains attached to the main cotton leader. Some such scheme for easily removing the spoons is a great convenience because the wet spoons soon tarnish when left exposed to the air. To prevent tarnishing the spoons should be removed at the end of the day's fishing and placed in a bucket of salt water or wet sand.

The swivels used are of two types. Most spoons sold in the stores have the closed or barrel type attached but the wire knobs inside the barrel may wear down and break. The open type of swivel is preferred because the wire knobs can be seen through the openings and the swivel exchanged for a new one when wearing occurs.

Markers. In prospecting for a school a boat may be trolling for some time with no sign of fish and then suddenly have two or three strikes at once on each line. By the time the fisherman hauls in and resets each line considerable time has elapsed and the boat has covered

quite a distance. It is then difficult to circle back and pick up the spot where the strikes occurred. Some fishermen carry a marker that may be heaved overboard at the point where the strikes occur so that the place can be picked up again without trouble.

The marker is a small float that supports a light flagged pole 6 to 10 feet long. The lightest marker is a cork float about 18 inches square and 4 inches thick, supporting a bamboo pole. The float is often of wood. The flagpole is passed through the float and weighted on the bottom end to insure floating upright.

Detecting a Strike. The drag of the line bends the pole tip backward. The rolling of the boat causes a motion of the pole tip due to lessening and increasing strain, but this slow movement with the boat roll is easily recognized and not confused with the more rapid jerking of the pole tip when a salmon is hooked.

Stiff poles are more apt to break with the sudden extra strain of a boat roll. In some cases this is obviated by using a coiled wire spring at the pole tip, but springs have not met with general favor.

Landing Fish. Hauling in the line takes some time and the hooked salmon has time to wear himself out fighting against the drag of the leads so that pulling him alongside is usually a hard dead pull without excitement. In shallow short-line fishing the salmon is more quickly pulled in and often puts up a hard fight, charging back and forth, even jumping clear of the water, tangling the gear generally and sometimes wrecking it. Silver salmon are credited with fighting much harder than Chinooks. Small Chinooks are said to fight harder than large fish, but this is probably due to the fact that small fish are more frequently hooked near the surface and on the shorter lines.

Some fishermen use a large landing net to bring the fish on deck, but a gaff hook is more commonly used. Sometimes the fish is so exhausted that he may be landed by a hand inserted in his gills. To prevent the fish flopping on deck he is killed by clubbing over the head with the gaff hook or a special club carried for the purpose.

Hauling in Lines. Practically all hauling in is done by hand. A few fishermen have small drums operated by the engine with rod and gearing, but this power hauling saves only the first (and hardest) pull to the first leader as weights and leaders can not be wound on the drum.

To prevent the line cutting the hands most men wear over the fingers a three or four inch section of automobile rubber inner tubing. The stores sell rubber "clinchers," which are a circular band of thick rubber with a sunken groove for the line and intended to be worn over the hand as is the auto tubing. The clinchers seem to serve better when cut in two and a cord used over the back of the hand instead of the complete rubber ring.

The line is coiled on the deck or in a small cracker box with the hooks inserted in notches in their proper order. The leaders are coiled separately from the main line in a smaller coil near the hook so that the bait or spoon can be thrown far out and tangling avoided.

Lost Fish. An attempt was made to learn the percentage of strikes that are lost but no records are kept and the opinions of fishermen are at such variance that nothing of value was learned. The percentage of lost fish evidently varies from time to time, possibly with the degree of hunger of the fish. Fishermen claim that on some days one-third of the strikes are lost, but on other days practically every fish is landed.

Whether or not small Chinooks are lost more than the large was not determined. The majority of fishermen think that many more small fish are lost than large, but they cannot be sure but that the small fish were silver salmon in most cases. Opinion is agreed that silver salmon are lost more than Chinooks and two reasons are given. Silvers are said to fight harder and their mouths are more tender. It is noticeable in looking over a mixed catch of the two species that many of the silver salmon have the lower jaw torn apart.

Salmon after being securely hooked are often attacked by enemies that are following the school. This is apparently more common in the northern waters, but is not uncommon at Monterey. Sea lions and seals are said to play a part, but sharks are the chief offenders. Sharks are often seen following a hooked salmon while the lines are being hauled in, even coming alongside, pursuing the salmon till he is hauled out on deck. It is no uncommon thing to see a 15-pound salmon delivered that has been bitten in two, leaving only the head and a little of the body on the hook. Spoons, leaders and leads are often lost from sharks biting off the lines and trolling is seriously interfered with, particularly along the northern coast and especially at Nogo and Shelter Cove.

THE FUTURE OF THE SARDINE.*

By WILL F. THOMPSON.

Our greatest fishery is that for the sardine; indeed, it is overwhelming in importance, constituting during January, February and March of 1920 about 85 per cent of the total fish of all kinds taken. Will the sardine remain, or will it vanish at times as does its cousin the herring of the North Atlantic, and as the sardine itself probably does in British Columbia and Alaska? Upon the answer to that question depend millions of dollars and the welfare of a great industry. What are we doing to answer it?

We have not known thus far whether or not our sardine fishery is subject to great fluctuations—its history is so brief, having begun in 1914. It is possible to surmise that it is, because in the North Pacific this same species of sardine was practically unknown until two years ago—indeed the occasional specimen that was taken with the herrings was hailed as a curious stranger. Then they came in a great flood, cluttering the traps and the nets, and a canning industry of importance sprang into being. And if they were lacking once they may well be lacking again, not only in British Columbia but in California. So the most ordinary business sense dictates an energetic inquiry into the probability that such great changes will occur in California, and into the chance of foreseeing them.

This is, you will note, entirely aside from the chance of overfishing. And we do not know enough about our Pacific fisheries to know whether they can stand anything approaching the strain that the Atlantic herring and sardine have stood. Perhaps even in the Atlantic it is possible that the herring or sardine will one day suffer from man's

* California State Fisheries Laboratory, Contribution No. 22.

operations as have other species. Our experiences on this coast have not been reassuring—that is certain—as witness the disastrous story of the halibut and salmon, for which our only great fisheries existed before the sardine and albacore became of importance. But before we can discuss overfishing, before we can tell whether it is happening, we must know something about those great fluctuations mentioned above, which may be confused with it. Indeed, in the sardine fishery the great natural changes in abundance may be so overwhelming as to completely overshadow depletion.

To the study of these changes in abundance we have therefore addressed ourselves earnestly, along lines suggested by a scrutiny of the phenomena in the herring and other fisheries. It has been shown that the relative success of the spawning seasons is of predominant importance in explaining these changes. It has been found in the herring fishery that in some given year the spawning was very successful, and that the result was a vast number of herrings of a single age, and as year after year this great age-group became older it made the fishery very successful for that particular size to which it had attained.

To make this point clear a diagram is attached which, while it does not represent the actual condition in any particular fishery, may for our purposes be thought of as applying to that for the sardine.

The successive years are shown at the various levels, and the ages are shown in succession from left to right. With each passing year the groups fall each into the next higher age class, and thus the predominating group passes successively through the ages from the third to the eighth. The oblique line traces its course. The height of the blocks represents the relative importance of the particular age considered in the catch. It will be noticed that each age-group becomes smaller as the years go on, because of the annual natural death of a certain proportion, in this case assumed to be a fourth.

In the case of the herring a successful period of fishing was ushered in by the incoming of just such a highly successful age group as is first shown in the third year old class on the diagram, and a poor period was characterized by its lack. Such a phenomenon may be happening in our sardine fishery; and we are analyzing the catch to see whether it is or not.

For instance, during last season, the first we investigated, the group we may regard as being in their fourth year predominated and made, at Monterey, a good pack for “half-pound oval” cans, much as the dominating class in our diagram was in 1904. Will this year’s catch be of fish one year older, hence less choice, and will the next be of fish two years older? Or will the catch continue to be of the same size and equally good for packing such cans? In other words, do the age-groups of fish vary widely in their abundance, as we have represented in the diagram, and will the fishery vary between success or failure with their growth in size, and with the presence or absence of a successful year? The packer, wondering whether the fishery is to remain good, and whether he will be able to pack “quarter oil” sizes, or obtain good “half-pound oval” sizes, naturally wishes to know the answer. We already have the catch of last year analyzed. What will our analysis this year show? It should, if we obtain our material and know from it

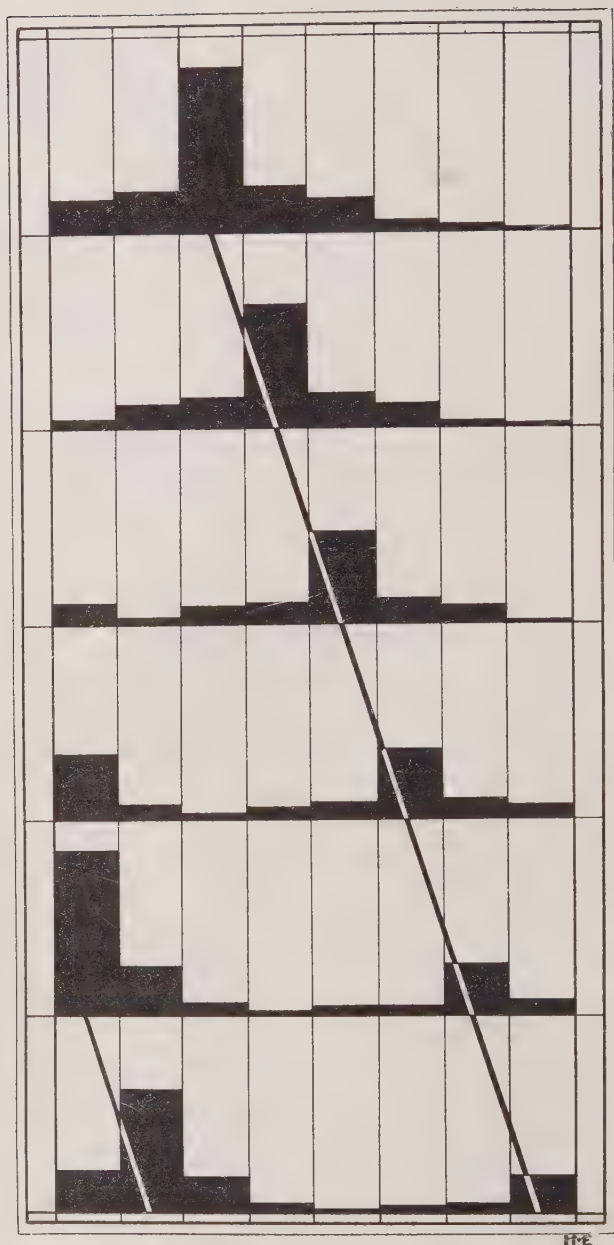


FIG. 20. Diagram showing theoretical effect of an abundant age group on the catch of successive years. The height of the blocks represents the relative abundance. If the diagram is thought of as applying to the sardine fishery, the following classification might hold:

- Age I—Too small for canning.
- II—"Quarter Oil" sizes.
- III and IV—"Half-pound Oval" sizes.
- V to VIII—Pound Oval and larger.

whether the predominating class is a year older, answer the questions of the packer, and indicate what we may expect in the future. Perhaps, when we know the exact rate of growth, we may be able to prophesy very exactly the character of the catch. Who knows, indeed?

But note the proviso, *if we know the rate of growth*. That indicates the importance of the fact upon which it is necessary to lavish much care and thought. It is a cornerstone for our edifice. So we are concentrating upon age and rate of growth.

Yet this knowledge of age is not sufficient unto itself. We must know whether our analysis of the catch really shows which age predominates. And there is only one way to do that, namely to take extensive series of samples for observation and comparison throughout the year. So there are two men stationed, one at Monterey and one at San Pedro, who are doing nothing else. Last year we obtained a great series of samples and are subjecting it to the closest analysis to see whether the age that predominates does so because of its actual abundance or because of some influencing factor. And so, also, the same is being done this year for comparison, to see whether the dominating class does become a year older. So far as we know, no fisheries investigation has been based as thoroughly and as carefully as will be that of the sardine.

And so we are confident that we will be able to answer the queries of the packer and the fishermen. We will be able to determine whether or not the fishery is to be one that varies greatly from success to failure through periods of years. We will be able to prophesy, if it is possible, as to the character of the coming catch.

But our objects are also to meet many other queries of the dealer, the packer, the fisherman, the legislator and the public, and what we have said in this article covers but one phase of our investigations; there are others as important. And we hope ultimately to be able to meet competently and scientifically that grave question which always awaits us in all discussions of the fisheries, that of the presence, the absence or the probability of overfishing, and its remedies.

CALIFORNIA FISH AND GAME

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All material for publication should be sent to H. C. Bryant, Museum of Vertebrate Zoology, Berkeley, Cal.

FEBRUARY, 1921.

Ignorance of the law is no excuse for violation of it. Therefore, because of continual changes, it is most necessary that you acquaint yourself with the existing statutes before going afield.

A SALMON NUMBER.

Certain details of the life history of the Chinook salmon, one of California's finest food fishes, have long been a mystery. Does a salmon always return to the stream where it was born? Why do salmon refuse food when in fresh water? Where do the two- and three-year-old salmon feed when in the ocean? Answers to these questions are being sought by scientists to complete our knowledge of the life and habits of this notable fish. In this January issue of CALIFORNIA FISH AND GAME we present a "Salmon number" containing several contributions bearing on the above points which merit thorough perusal by all our readers. Not only are these papers of more than ordinary interest so far as subject matter is concerned, but those by Dr. J. O. Snyder and W. L. Scofield are published results of the marking experiments and other investigations on salmon undertaken by the California Fish and Game Commission.

KLAMATH RIVER SALMON THREATENED WITH EXTERMINATION.

The Electro-Metals Company of San Francisco and Mr. A. P. Seybold of San Francisco, have each applied to the Federal Power Commission for preliminary permits to build dams on the

Klamath River to divert water for power projects. One of these projects is located above the town of Orleans and the other a few miles below this place.

Nothing in recent years has so threatened the salmon fishery as these proposals. The Klamath River still has a good run of salmon. A large cannery is located at the mouth of the river and large numbers of fish are used for food by people living along the stream. A large take of salmon eggs for the use of the hatchery is also secured on the Klamath River near Hornbrook. If the Federal Power Commission permits the building of these dams, 90 per cent of the spawning ground of the salmon in this river will be destroyed and ultimately the whole salmon run.

The power companies will argue that fish ladders can be built over the dams. Ladders, of course, could be built, but there is little chance that they would be successful on dams 100 feet high, or over. Furthermore, such fishways would be an impediment to the young salmon attempting to reach the ocean from the spawning grounds. Nor could a successful hatchery be maintained below these dams, for the salmon reaching such a station would not be mature and it would be impossible to hold them until ready for spawning.

The catch in the Sacramento River and other rivers in Alaska has fallen off during the past few years; and unless some of the better streams are protected as spawning grounds for these fish, the salmon will soon be a thing of the past. There is no opposition to power projects in general, but there is opposition to projects which destroy spawning grounds of salmon and other food fishes. Other streams where there is a poor salmon run, as for instance the Trinity River, should be utilized rather than the best of our salmon streams.

It is to be hoped that the above applicants will be denied permits and that the Klamath River and its tributaries will be permanently maintained as spawning grounds for salmon and steelhead, and thus continue to be a source of supply for the fishing industry and a resort for the angler.

IN MEMORIAM.

RALPH W. REQUA.

Ralph W. Requa, a former trusted employee of the Fish and Game Commission, departed this life July 7, 1920. He was born at Xenia, Kansas, November 26, 1874, being the son of George W. Requa, one of the pioneers of Kansas and a prominent citizen and politician.

Ralph Requa graduated from the schools of his native state and at the age of eighteen entered the United States Postal Service as a delivery mail clerk. This work was not to his liking, as he was interested in the conservation of fishes, so he soon entered the employ of the United States Bureau of Fisheries.

For several years he was employed as a messenger in the distribution of fish by the Federal Bureau of Fisheries, and the knowledge he obtained in traveling over the different sections of the United States in this work, was of great value to him later.

Mr. Requa resigned from the Bureau of Fisheries in June, 1895, to accept a position with the California Fish and Game Commission. He was placed in charge of the distribution work at Sisson Hatchery and subsequently became foreman and assistant superintendent, greatly assisting in the building up of this hatchery, as his practical knowledge was of great value in all lines of fish-cultural work. Considerable of his energies were devoted to the improvement of automatic screens for the saving of fish from destruction in ditches and canals, and he patented several devices for this purpose. Many of the best screens in the state have been installed under his direction.

His arduous duties as superintendent of one of the first distribution cars undermined his health and for the last six years he was employed only periodically by the Commission on screens and aquarium exhibitions, although in charge of the salmon experimental work at the experimental station in Bidwell Park near Chico. An expert on the arranging and placing of fish in aquariums, his work at the different county and state fairs attracted wide attention.

He was married to Florence Getchell in 1901. Her death in November, 1918, hastened his end. He left two children, Francis and George Requa.

Untiring in his efforts in all lines of fishculture, there was no day too long or task too hard for him if he thought the work depended on his services. He was one of the faithful employees who have made the work of the California Fish and Game Commission one of the most successful of any in this or any other state.

Ralph Requa was a man of the highest integrity, and his associates will ever remember him as a kind friend and a loyal champion of those whom he trusted as his friends. No nobler tribute can be paid him than the following extract from



Ralph W. Requa.

a letter written by a friend and collaborer of his in the work of the Fish and Game Commission: "He went with me into the high mountains and started me right in the fish planting business. I learned him then, the heart of him, as men will do when all alone in the high country. I formed a strong attachment for him and have always held it. He was another example of a faithful employee, martyr to a cause."

In the passing of Ralph Requa, the state has lost a good citizen, his children, a kind and loving father, and the Commission a dependable and faithful employee.—W. H. S.

THE 1920 BIENNIAL REPORT.

The Fish and Game Commission's 1920 biennial report to the Governor will be off the press early in the year. It is to be bound in an attractive cover giving a four-color reproduction of a Loch Leven trout. The report will contain full statements of the work and accomplishments of the past two fiscal years by department heads, together with many illustrations. The appendix will include statistical reports on fish planting, license sales, arrests, seizures and expenditures. In spite of war economy, the Commission has made a remarkable showing. Outstanding features of the past biennium are: The successful rearing and planting of over 30,000,000 trout and over 23,500,000 salmon; the splendid administration of commercial fisheries and valuable scientific research connected therewith; the establishment of a great chain of game refuges; and a worth while educational and publicity campaign.

SPORTSMEN'S AND ANGLERS' ORGANIZATIONS.

The sportsmen's and anglers' organizations of California or any state may be considered as wild life educational assets. Through them a greater number of people are made familiar with the fish and game laws; right sportsmanship is stimulated and the importance of conservation is better appreciated. The Fish and Game Commission stands ready to encourage these clubs in any way possible, for it feels that by cooperating with them both the sportsmen and the Commission will be benefited; the sportsmen will be more alert to the work of the Commission in its effort to insure the ever increasing numbers of fishermen and hunters with an adequate supply of fish and game, and the Commission by being more in touch with the people, will be better prepared to meet their demands and any lurking spirit of dissatisfaction.

The Commission feels that it can be of service to these organizations by loaning its splendid wild life films (or stereopticon slides) and providing a lecturer to explain the pictures, when desired, and acting as a clearing house for dependable information on game resources, fish and game conditions and fish and game laws.

PROPOSED FEDERAL HUNTING LICENSE.

Those interested in the working out of the Migratory Bird Treaty Act are disturbed over the small appropriation available for the enforcement of the act and the consequent small number of federal game wardens. The congressional appropriation of \$142,500 permits the employment of but 29 salaried wardens.

That sentiment favors a stronger governmental support of the measure is evidenced by the action taken by the International Association of Fish, Game and Conservation Commissioners. At its recent meeting in Ottawa, the association adopted a resolution calling for the issuance of federal licenses for hunting migratory birds. Licenses in the form of special stamps to be issued by postmasters and attached to state licenses were recommended. It was estimated that the revenue from such licenses would amount to between \$1,000,000 and \$2,000,000, an adequate sum to be used for the protection of game.

GOLDEN TROUT.

Golden trout received wide distribution owing to the successful results in the hatching and rearing of golden trout at the Mount Whitney Hatchery in Inyo County. The California Fish and Game Commission has been able to stock many barren streams and lakes in the southern Sierra with golden trout. Until recently the stocking of streams was dependent upon the capturing of golden trout by hook and line and the transportation of the fish thus caught. Now the Mount Whitney Hatchery has an output of nearly one million golden trout annually.

During the past fall, under the direction of Commissioner M. J. Connell of Los Angeles, the golden trout fry from the Mount Whitney Hatchery have received wide distribution. With Deputy E. H. Ober in charge of the pack train, plants have been made in tributaries to the Middle Fork of the San Joaquin, Madera County. Until they received their quota of golden trout these streams were barren of fish life. The plan is to plant desirable streams and to keep the stock pure. Crystal Lake, which was planted in September, 1918, was found this year to be teeming with beautiful fish ranging from five to ten inches in length.

WHY?

Although the Fish and Game Commission has been having splendid success in convicting violators of the fish and game laws, yet their efforts are occasionally handicapped by some judge who fails to make a conviction possible. As evidence, the following may be cited:

Deputy Harrington arrested Mr. H. Zirn of San Pedro for having in his possession 250 pounds of spiny lobsters over the size limit of sixteen inches. Most of these lobsters measured from seventeen to twenty-two and a half inches in length, and were consequently illegal. When the case was tried by one of the San Pedro judges, two of the lobsters properly labeled were presented as evidence, but because these lobsters had been boiled to preserve them, the judge ruled that the evidence had been changed and therefore that the violator could not be ruled guilty.

Why should such unreasonable technicalities be advanced allowing a guilty violator to escape punishment?

of Richmond Harbor. These nets were confiscated. One was found to be 1800 feet in length and the other 1600 feet, making a total of 2400 feet of net. One of the owners of the nets was captured and paid a fine of \$100 in addition to the loss of the nets confiscated.

BOTTOM DROPS OUT OF THE FUR MARKET.

According to a letter written by Funston Brothers and Company of St. Louis, published in the Illinois Sportsman, October 14, 1920, the fur market is still stocked with the bulk of last year's catch and the above named company advocates, therefore, little if any trapping during the coming season. To explain the situation they write as follows:

"One of the principal reasons why the dealer is carrying such an enormous stock is due to the fact that the manufacturing end of the business has had a strike since last May. Ten thousand men have been out, and a great many of them are still out. This has resulted in the fur dealer being compelled to carry the furs all

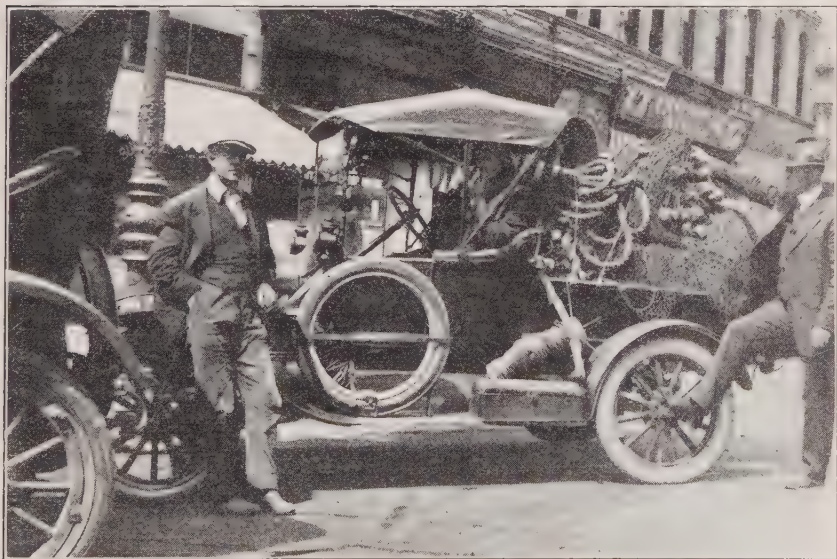


FIG. 21. Net 2,400 feet in length confiscated by deputies of the Fish and Game Commission at Richmond Harbor, August 31, 1920.

NETS CONFISCATED.

On August 31, 1920, deputies A. Mack, Bert Leahy and M. S. Clark of the Fish and Game Commission discovered two large "illegally" used nets at the mouth

during the manufacturing season, and he still has them on hand with a new fur season coming on."

It is stated that the market price of furs will be reasonable, the fur dealers being willing to sell at a loss, and that

until conditions improve it is advisable that the trapper should not trap and ship furs this season. If they do the prices which they receive will not be remunerative, as financial conditions among the manufacturers are such that the fur dealers will be unable to buy much of the new fur.

Little is said of the conservation side of the question, but in order that the fur-bearing animals marketed should be saved from extravagant waste, it seems even more advisable to discourage the seasonal trapping of the year.

COMMISSION COMPLIMENTED BY BUREAU OFFICIALS.

Lewis Radcliffe and Henry O'Malley of the United States Bureau of Fisheries have recently been making an investigation of the fisheries of California and the conservation work of the state's Department of Commercial Fisheries. These officials appeared very much pleased with the work carried on by the California Commission, and stated that the Bureau of Fisheries appreciated the public spirit of the Commission in maintaining the preservation laboratory at San Pedro until appropriations would allow the Bureau of Fisheries to again support the project.

The Bureau of Fisheries is at present making a thorough investigation of the methods of caring for and preserving fishing gear in which \$15,000,000 is now invested in the United States, exclusive of boats. The life of nets and other gear is very short under existing conditions, and other ways and means of increasing the length of time they can be used are being sought.

HUNTING AND ANGLING LICENSES.

There has been a remarkable growth in the number of hunters and anglers in the State of California, as evidenced by the sale of licenses. In 1914 the number of angling licenses totalled about \$4,000 and the hunting licenses about 165,000. In 1919, the anglers numbered over 145,000 and the hunters 178,000. According to current compilations of the number of hunting licenses issued in the various states, Pennsylvania, New York, Ohio, Illinois and Wisconsin, in the order named, lead California in the number of

hunting licenses sold. In the whole United States there are about 7,000,000 hunters who pay a license fee and it is estimated that over 3,000,000 more are exempted from the fee by various state laws.

DUCKS MOVE TO NEW FEEDING GROUNDS.

The lack of fresh water in the larger streams has greatly increased destruction to pilings by the teredo in or at the mouth of the San Joaquin-Sacramento rivers. Many wharfs along the Carquinez Straits have had to be abandoned and continual repairs are being made on others. Soft-shelled clams which heretofore have been restricted to San Pablo Bay are now thriving in Suisun Bay, with the result that such ducks as the canvasback and the lesser scaup are utilizing the upper bay more largely as a feeding ground.—H. E. F.

HELP SAVE THE WOOD DUCK

The wood duck, said to be the most beautiful duck in the whole world, is protected by federal law, but not all shooters are able to identify the females, or the males in immature plumage. In an attempt to prevent the killing of wood ducks by mistake, the Department of Conservation of Massachusetts has issued a poster giving colored illustrations of the wood duck in flight, showing its different plumages, with the request to "look before you shoot."

The following marks for field identification are offered:

(1) Any duck with a white breast found near streams or fresh-water meadows in September or early October is almost certainly a wood duck.

(2) Any ducks, which when suddenly startled, fly away without quacking, have the tail longer and the neck shorter than that of the black duck, will probably be wood ducks.

(3) Any duck which can be heard uttering a peculiar note, sounding like "Oo-ek," is a wood duck.

GAME LAWS FOR 1920.

The total number of game laws enacted in 1920 probably will not exceed 60, which is about normal for "even" years, when only a few states hold legislative sessions. In the laws enacted further progress was

made along the line of harmonizing state legislation with the migratory bird treaty act regulations.

The most important changes affecting big game were in New York and Quebec. New York reenacted the buck law and limited the hunter to one buck a season. The deer season was also modified in several localities. In Quebec the season was shortened 19 days on deer and bull moose, except in four counties, and 50 days on caribou.

Legislation of far-reaching importance looking to the preservation of quail and other upland game birds included an act of Congress, approved December 18, 1919, prohibiting the sale of upland game birds in the District of Columbia, and an act in Maryland prohibiting the sale of quail, ruffed grouse, introduced pheasant and wild turkey in that state.

For the convenient use of sportsmen and others the Biological Survey of the United States Department of Agriculture has compiled information resulting from game legislation, and this has been published as Farmers' Bulletin 1138. This contains a summary of federal, state, and provincial laws for 1920; a summary of laws relating to seasons, licenses, limits, sale and export; disposition of game raised in captivity; the text of the Lacey Act regulating interstate commerce in game, and of the tariff act prohibiting importation of plumage; the law protecting birds and their eggs on federal bird reservations; the regulation regarding hunting on national forests; the treaty for the protection of migratory birds; the migratory bird treaty act and the federal and Canadian regulations; text of order of Secretary of Agriculture permitting the killing of reedbirds; a list of officials from whom copies of game laws may be obtained; and a list of the publications of the Department of Agriculture relating to game. Farmers' Bulletin 1138 may be had upon request of the United States Department of Agriculture, Washington, D. C.

WRONG SEASON ON DOVES.

On the opening day of the dove season (1920), the writer and one of his friends went out for a try at the doves. We had to go about two and a half miles to an orchard where we found plenty of the birds. I got thirteen and my friend got eight. He had a twenty-two rifle and I used a shotgun. I could have taken my limit but I waited until I could take two at a shot, making them come at two and a half cents apiece.

As we started to come home we took a longer way back in order that we might shoot some jack rabbits for the dogs. I found three dove nests while hunting for the rabbits and my friend found four. Two of those which I found had eggs in them and one had squabs, almost ready to fly. The nests which my friend found held two eggs each. This seems to me to demonstrate quite clearly that the dove season opened too early.—CHARLES FORLETT, *Merced, California.*

TWO DEER AT ONE SHOT.

We all hear of the man who discovers himself short of ammunition and uses this as an excuse for his inability to secure a deer, but it is seldom that we hear of a man lucky enough to secure his limit of deer in one shot. The opening day of the season found Fred McKenzie, an employee of the Ukiah post office, together with friends, camped on Baldy Mountain. On the day before leaving this camp, two three-point bucks appeared standing side by side. McKenzie pulled up and shot, the bullet passed through the neck of the first deer and struck the second in the base of the brain.

Although this sounds like the usual hunting story, it has been verified by Fish and Game Deputy B. H. Miller.

FACTS OF CURRENT INTEREST.

A more than ordinary rainfall during the winter months so scattered the ducks that bags have been small.



The comparatively small run of salmon the past year has emphasized the necessity of a careful scientific investigation of the life and habits of this fish, such as is in progress.



The first of the year finds the sardine canneries burdened with a large part of last year's pack. As the price of canned sardines advanced in price but a very small per cent, a reduction in price to move last year's pack means a distinct loss to the canner.



A new State Fisheries Laboratory is under construction at San Pedro. This laboratory will afford facilities for the scientific staff engaged in investigations on the commercial fisheries.



During the past biennial period 1891 arrests for violation of the fish and game laws have been made, and fines totaling \$46,373 collected.



State lion hunter Jay Bruce has succeeded in killing thirty mountain lions during the past year. When it is known that this means a saving of at least 1400 deer, it will be seen that the salary outlay for Mr. Bruce is well spent.



A fisherman on the Sacramento River arrested for having illegal nets in his possession was recently sentenced to one hundred days in jail by Judge Quince of Benicia.

HATCHERY NOTES.

W. H. SHEBLEY, Editor

TROUT AND SALMON DISTRIBUTION.

The distribution of trout and salmon fry from the hatcheries and ponds of the Commission was completed November 5. While the number of fry distributed was not as great as last season, the fry were in better condition and the distribution was systematically carried out, so that the results obtained were very gratifying.

With very few exceptions all the shipments were under the supervision of the car messengers and the hatchery employees and the fry were planted in good condition. Some of the shipments were turned over to applicants who have had several years' experience in planting fry and who used their efforts to make the work of distribution in the streams and lakes in which they were interested a success. On the long trips from the railroad stations to the interior districts, there were less fish lost than in any previous season, judging from the reports received from applicants.

There were about eight thousand cans containing sixteen and one-half million trout fry sent out from the hatcheries, by truck and distribution cars and, as far as can be learned, there was only one serious loss during the season and that was caused by the breaking down of a truck. This shipment was turned over to the Forestry officials who sent out a driver without an assistant. This driver neglected the fish during the time that his truck was being repaired and consequently a great many of the fish were lost. Our men on the distribution car were not to blame, as the Forestry officials who have had experience in planting fish were to handle this shipment. Mention is made of this to demonstrate the fact that our system of planting the fry is very successful.

The demand for trout fry was very great this last season owing to the depleted condition of the streams caused by the excessive fishing during the period of low water which has prevailed over the

entire state for the last three years. The fish were confined to the larger pools and were easily taken by the anglers. Some of our best trout streams were fished almost to depletion during the period of drought and an increased number of fry will be necessary to restore the streams to normal conditions again as well as a shorter open season, so that the fish will have a chance to grow.

The present season in most of our fish and game districts is open too long to give the fry a chance to grow and mature into breeders. The season should be shortened by the coming legislature, so that the fry will have a chance to grow and give the anglers better sport.

SALMON EGG COLLECTING, FALL OF 1919.

The extremely low water of last fall prevented the salmon from entering the tributary streams of the Sacramento River on which are located the egg-collecting stations of the Bureau of Fisheries. Consequently, the number of eggs collected was very much smaller than usual and all the eggs that the Bureau could spare for our Mount Shasta station was 4,235,000.

The resulting fry were held and fed until late in the spring, when 3,100,000 of them were placed in the large rearing ponds connected with the Mount Shasta Hatchery. Here they made a rapid growth and were released in excellent condition during October in the tributary streams of the headwaters of the Sacramento River.

Twenty thousand of the fry were marked and will be liberated as soon as all danger of fin regeneration is over.

The run of salmon on the Klamath River did not reach our egg-collecting station in as large numbers as we expected as the lack of rain caused them to spawn lower down the river and in some of the small tributary streams miles below our racks.

A large percentage of the breeding salmon that enter the small tributaries of the Klamath River as well as the Sacramento tributaries are taken by persons with spears at a time when they are hardly fit for food. The taking of these fish by persons desiring them for

Extensive plans were made this fall to take a large number of salmon eggs at our Klamathon Egg-Collecting Station. The Bureau of Fisheries also was prepared to operate its Battle Creek and Mill Creek stations on the Sacramento River to their full capacity. The unus-



FIG. 22. Racks in the Klamath River used to capture salmon for spawning purposes. Photograph by L. J. Stinnett.

food, when the fish are on the spawning ground is not only destructive to natural propagation, when confined to the number that can be legally taken, but there is a wanton waste of the fish by persons who spear them on the spawning beds and are forced to throw them away when they find them in no condition to use as food. Oftentimes fish are speared until a fish is taken that is considered edible. A large majority of the breeding salmon after they reach the spawning grounds are emaciated and covered with patches of fungus, making them unfit for food.

The take of salmon at Klamathon during the fall of 1919 was 4,974,000 eggs. Of these eggs 3,307,000 were taken to the new Fall Creek Hatchery, located twelve miles above Klamathon on Fall Creek, one of the finest streams of water for the rearing of fish on the coast. The resulting fry were placed in ponds and held until October, when they were liberated in good condition.

usually heavy rainfall during November caused the streams to rise very rapidly and at the height of the salmon run, November 17, the racks at Klamathon were so badly damaged by the high water that the salmon that were ascending the river escaped above the racks and our take of eggs was considerably less than expected.

The racks at Mill Creek and Battle Creek stations of the Bureau of Fisheries were washed out at the height of the salmon run. The loss in eggs that could have been collected from the salmon which escaped above the racks is estimated at between 20,000,000 and 25,000,000, at all stations damaged by the high water. This would not be so serious during normal seasons, as the natural propagation would take place on the spawning beds and a certain percentage of the eggs would hatch, but during periods of torrential floods in the streams frequented by the spawning salmon, the shifting sand

and gravel disturbs and moves the eggs and a great many of them are destroyed or are buried so deep that they cannot possibly hatch out.

The total take on the Klamath River was about 7,000,000 eggs, and from unofficial reports received the number taken by the Bureau of Fisheries was approximately the same.

While the loss in eggs is to be regretted we will be able to give the eggs collected extra care and, in a measure, make up for the shortage of eggs at the hatcheries.

SAN JOAQUIN RIVER SALMON.

The Kerckhoff Dam, property of the San Joaquin Light and Power Company, that has recently been completed, near Aubrey's on the San Joaquin, prevents the passage of the salmon to their former breeding grounds on the upper reaches of the river.

The Merced River will no longer afford a spawning ground for salmon, as a large irrigation project is planned that will hold back the flood waters of the Merced in a lake to be made by the construction of a high dam across the river near Exchequer. Plans had been made for the construction of fishways over the small dams in the

Merced River, property of the San Joaquin Light and Power Company, and arrangements made for their construction, but the plan of the large irrigation reservoir makes it impracticable to attempt any further efforts to perpetuate the run of salmon in the Merced River. With the completion of the Kerckhoff Dam and the proposed dam at Exchequer, the spawning grounds for salmon on the San Joaquin River and its tributaries are practically all cut off from the breeding salmon. During seasons of normal rainfall a few salmon will probably spawn near Friants, below Power House No. 4 of the San Joaquin Light and Power Company. This area is very small and would not have any effect in keeping up the run of salmon in the river.

An experimental salmon culture station is being established on the San Joaquin River with the object in view of determining what the expense will be of collecting the eggs near Friants in the fall and transporting them to the hatchery on Willow Creek, a distance of about thirty-five miles, hatching the eggs and rearing the fry in ponds, the fry to be held in the ponds until the following fall, then convey them by auto truck to the river below the Kerckhoff Dam.



FIG. 23. Fishway while under construction at the Folsom Dam, on the American River. This fishway, recently completed, is one of the highest and best yet constructed in California. Photograph by A. E. Doney, October 24, 1919.

Two or three important features enter into this undertaking that will be the determining factor as to whether a successful salmon culture station can be established or not on the San Joaquin River. One is the expense of transporting the fry from the ponds to a point below the dams and the other is the screening of the large canals taking water from the San Joaquin River, from Friants to the diversion at the Temple Canal.

The expense on the transportation by auto truck of 2,000,000 or 3,000,000 fry each fall from the rearing ponds to the river below the dam should not stand in the way of keeping up this valuable supply of food fish for the people. A three-ton truck, with two men in charge, could transplant the fish in thirty days.

The river bed from this point to the Kerckhoff Dam, which diverts the water through a 17,000-foot tunnel, is dry during the summer and fall, as all the water is used for the operation of the power house. Under present conditions all the salmon that ascend past this point on the river, during the spring when the river is high, will pass the power house and lie in the pools between the power house and the dam for a distance of approximately fourteen miles. These will perish during the summer and fall when all the water of the river is diverted through the tunnel for power purposes. These fish cannot be saved at present, and very few are taken for food as the river from the dam to the power house flows through an almost impassable gorge, where few persons ever enter. If the plan of hatching the eggs at Willow Creek proves a success, racks will have to be placed across the river below the power house and the fish prevented from passing into the gorge.

There is a project started that will probably be completed during the next year or two, which consists of a high dam across the San Joaquin River at Friants to hold back the flood waters of the San Joaquin River for irrigation purposes. If this project goes through there will be no necessity for the racks as the salmon can be taken at the dam during the fall and their eggs collected and taken to the hatchery.

All of the above conditions must be carefully investigated and if it is practicable, plans must be made to save this valuable run of salmon on the San Joaquin River.

SALMON IN THE EEL RIVER.

The commercial fishing at the mouth of the Eel River and the spearing of the breeding salmon on the riffles on the upper reaches of the river necessitated the propagation of salmon in larger numbers on Eel River. Experimental work was carried on at an experimental station on Buli Creek, one of the tributaries of the South Fork of the Eel River and also in the main river near the mouth. The results of these experiments of the last three years have not justified the expense of establishing a permanent egg-collecting station on the lower reaches of the river.

There are several conditions on the lower reaches of the river that in our judgment makes it impracticable to establish an egg-collecting station in that region. The salmon when they enter the mouth of the river are compelled to remain in the large pond below Loleta until the river rises in the fall, as there is not enough water during the seasons of normal rainfall to allow the fish to pass over the wide, shallow riffles connecting the large pools from South Fork to the large pool at the mouth of the river.

As a rule the river rises to a considerable extent, but not before the majority of the salmon are caught by the commercial fishermen at the mouth of the river in the large pool. It has been suggested that eggs be collected from the fish in the large pool during the early fall before they ascend the river or are taken by the commercial fishermen but we find that the fish do not ripen in numbers great enough to justify the expense of seining them up and separating the few ripe ones from those that are green or immature. Furthermore, there is no water near the mouth of the river suitable for hatchery purposes. If eggs could be taken in sufficient quantities to justify the expense of collecting them they would have to be taken direct to Fort Seward Hatchery on the railroad, some sixty miles up the

river. The eggs collected would in all probability be in such small lots that it would not pay to keep the necessary help and equipment.

Any attempt to place racks across the main Eel River or the South Fork, anywhere near its mouth, is almost impossible as the loose nature of the formation is not solid enough to hold the racks and, even if this were overcome, the tremendous amount of water that comes down Eel River during flood periods, carrying logs and debris of all kinds would make it impossible to retain any kind of a rack in the river. Furthermore, if a rack could be built that would stand the flood water of the river when the salmon were running, the number of fish that would be entering the river would be all fresh run from the ocean and would have to be held too long in order to have them mature.

An egg-collecting station on Eel River or its tributaries must be situated far up the stream, away from the tremendous floods and the floatage matter in the river, and must be in the upper reaches near the spawning grounds, where the fish have spent the necessary time in fresh water for the breeders to mature.

A careful examination has been made of the Eel River and its tributaries for a suitable site and an experimental station has been located near Branscomb on the South Fork of the Eel River in Mendocino County, about one hundred and twenty-five miles from the mouth of the main river. The material for the racks, trap, cabin and temporary hatchery were ordered with the expectation that the station could be finished this fall in time to catch the salmon run that ascends the South Fork, the principal spawning stream of the Eel River system, but the unusually heavy rainfall during November delayed the hauling of the material and caused the river to rise to such a height that it became impossible to complete the work. Plans are being made to finish the work next season and to carry on the experimental work at this station to determine whether there are enough breeding salmon in this reach of the river to justify the expense of establishing a permanent station at this place to collect eggs for the Fort Seward Hatchery. At

this hatchery the eggs can be hatched and the fry reared to a suitable size to stock the Eel River and its tributaries.

It takes less fry to stock Eel River and maintain the run of salmon than any other river on the coast as there are few natural enemies of the young of the salmon to be found in the river. There are few predatory fishes, no diverting canals to carry off the water where fry are lost, or overflow basins, and very few water snakes or other natural enemies. If only a few million eggs can be collected and the resulting fry planted each season the run of salmon in Eel River can be easily maintained provided the fishing at the mouth of the river is regulated as well as the ocean fishing, where large numbers of salmon are taken each season.

In our judgment all net fishing should be prohibited in Eel River, as the salmon supply of that region will not stand for the heavy toll taken in the ocean as well as in the Eel River when the fish enter the fresh water to spawn. A law should be passed prohibiting all fishing in Eel River except by trolling. The steelhead trout would then have a better chance, as a considerable number of the adult fish are taken by the nets. The Eel River should be protected as a fish preserve to furnish both steelhead and salmon eggs for propagation.

Every precaution should be used by the Commission to prevent the introduction of any predaceous fish into the waters of Eel River as the stream is one of the few that can be depended on to furnish a large supply of steelhead as well as salmon eggs, if properly protected against too great a drain by commercial fishermen.

The commercial fisheries are increasing off the coast each season and the number of salmon taken in the ocean must surely lessen the number that enter the river to breed. As fish are in prime condition when taken from the salt water, fishing in the ocean should be allowed, but a restriction on the number that can be taken should be made. On the other hand, all net fishing in the Eel River should be prohibited.

COMMERCIAL FISHERY NOTES.

N. B. SCOFIELD, Editor.

SOME CONSIDERATIONS CONCERNING THE SALTING OF FISH.

Mr. Donald K. Tressler of the Division of Fishery Industries, U. S. Bureau of Fisheries, has recently carried on some very interesting experiments on the salting of fish.* Mr. Tressler's work has to do chiefly with the fishes of New England and the Eastern coast, but a study of his work might be of benefit to the packers of the Pacific coast.

Previous to this time very little work had been done on this phase of the fishing industry. It required the stimulus of the enormous demand for food caused by the war to arouse an interest in fish salting and a demand for better methods. The purpose of these experiments was to work out, if possible, a method of salting fish applicable in warmer climates, 70 degrees Fahrenheit and above.

The standards of quality differ from place to place, some localities demanding a hard, dry, salted fish, while others want a white, colorless fish with a softer meat. Two methods of salting are now in common use on the Eastern coast, the dry or "tight packed" method and the brine or pickle method. The former method is almost universally used in the south and the other method in the north.

From a study of the procedure followed at the various places on the Atlantic Coast where fish are salted it would seem that there are perhaps three general methods of applying salt to the fish: (1) the fish are immersed in a solution of salt which is kept saturated, or nearly so, by the addition of salt from day to day; (2) the fish are packed in water-tight containers with dry salt and are allowed to develop their own pickle;

*Some considerations concerning the salting of fish. By Donald K. Tressler, U. S. Bur. Fisheries, Doc. 884 (1920), pp. 1-55.

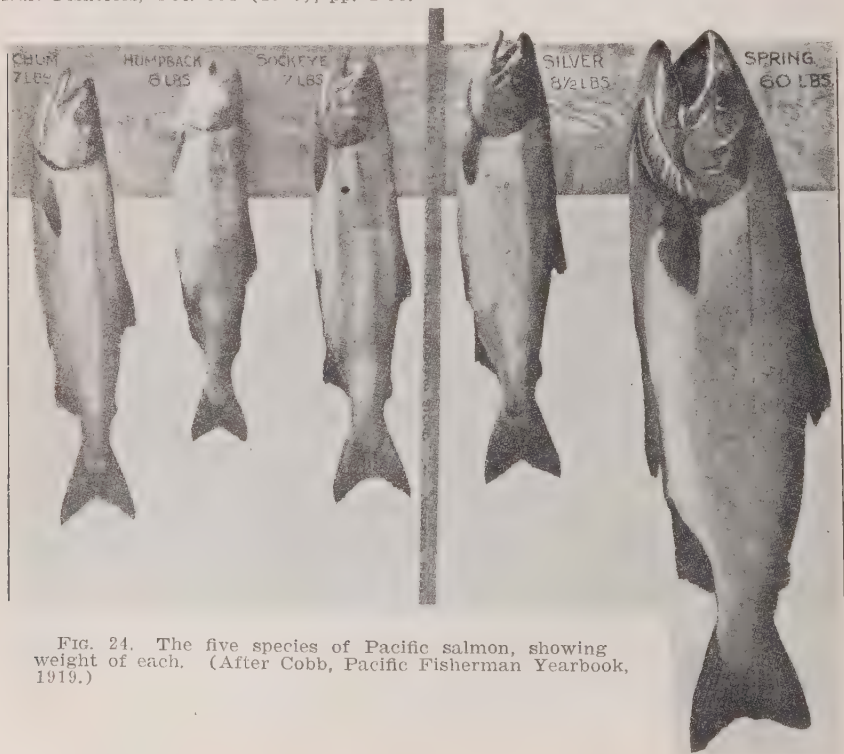


FIG. 24. The five species of Pacific salmon, showing weight of each. (After Cobb, Pacific Fisherman Yearbook, 1919.)

(3) the fish are packed in piles and the pickle allowed to run off the fish as it is formed. This last way is only used in cold weather in an emergency when no containers are at hand.

In storing of salt fish, these general methods are in use: (1) brine; (2) dry, with salt; (3) dry, with boracic acid. In case the first one is used, if the pickle becomes dirty, fresh pickle (salt solution) is added. New brine is always added if the fish are to be stored where it is not cool. If the fish are packed dry they are either sprinkled with dry salt or salt containing four-tenths per cent boracic acid. In all cases the fish must be kept at low temperature if stored for any length of time or they are very likely to "rust." "Rusting" is due to oxidation of the fish oil, giving the fish a dark-brown color. Packing in brine prevents this to a large extent.

Mr. Tressler has found that the impurities in salt exert a great influence on

may be kept at a higher temperature than fish salted in brine; the removal of all blood and viscera, including milt and roe, is absolutely essential for the salting of fish at high temperatures; and that during warm weather freshness of fish is essential to successful salting.

From the results obtained by Mr. Tressler, it seems very probable that fresh fish may be salted in any climate of the United States if the following precautions are taken:

1. All viscera and blood must be removed in cleaning.
2. Large fish must be split.
3. Fish must be salted in reasonably fresh condition.
4. No brine should be added in salting.
5. Salts low in calcium must be used.

—A. W. WELLS, *Bureau of Fisheries Preservation Laboratory.*



FIG. 25. Seining for salmon on the Sacramento River near William's Bar. Photograph by R. B. Heacock, April, 1916.

properties of the salted fish as to hardness, whiteness, etc. Pure salt is pure sodium chloride, but there are no salts on the market that are 100 per cent pure. Most American salt is of great purity. Calcium and magnesium salts and sulphates as impurities in salt retard the penetration of the salt into the fish. The investigator also found the following things to be true: That fish packed in dry salt, without the addition of brine,

SALMON CONSERVATION AND SALMON TROLLING.

The commercial method of catching salmon by trolling is described in an article by W. L. Scofield in this issue. The catching of salmon by this method has now become an industry of great importance to this state, Oregon, Washington and Alaska. The principal trolling districts in this state are in Monterey

Bay, off San Francisco and near Fort Bragg, Mendocino County. At each of these places about five hundred boats were employed this year. Before sea trolling became important in California salmon were nearly all caught by means of nets in the rivers which they enter at maturity for the purpose of spawning. To show the catch by these two methods we give the following from an article on "Ocean and Stream Salmon Catches," in the October issue of this magazine:

*Total Yearly Salmon Catch of the State
in Round Numbers.*

	River caught	Ocean caught	Season total
1919 ----	5,987,000	7,158,000	13,145,000
1918 ----	7,173,000	5,920,000	13,093,000
1917 ----	5,493,000	5,563,000	11,056,000
1916 ----	5,342,000	5,501,000	10,843,000

The salmon caught in Monterey Bay, off San Francisco and in the Sacramento

River are generally classed together as a unit under the assumption that they are the product of the Sacramento River. The following table shows the catch by trolling in these two outside regions contrasted with the catch by nets in the river:

	Monterey Bay	Outside San Francisco Bay
1919 -----	2,816,000	1,443,000
1918 -----	2,893,000	1,929,000
1917 -----	3,880,000	1,280,000
1916 -----	5,231,000	263,000

	Troll fish	Sacramento River
1919 -----	4,259,000	4,529,000
1918 -----	4,822,000	5,938,000
1917 -----	5,160,000	3,971,000
1916 -----	5,494,000	3,451,000

It will be seen that the Monterey Bay catch has been falling off. Contrasted with this is the catch in the Fort Bragg region which has steadily increased due



FIG. 26. The Monterey salmon fleet of fifteen years ago is now entirely replaced with power boats.

to the recent development of the industry at that point. The catch near Fort Bragg was less than half a million pounds in 1917, in 1918 it exceeded one million pounds, in 1919 it was a little less than three million pounds, and this year the catch exceeded three million pounds.

This catching of the salmon in the open sea has added greatly to the difficulties of conserving these valuable fish. Our state laws provide for closed seasons on all of our salmon streams during which time salmon may not be caught. These closed seasons were mostly established before the development of sea trolling and were designed to allow at least one-third of the fish to pass up the rivers to the spawning beds unhindered by nets, under the belief that if this portion of the run, together with the number which escape the nets during the open season, could reach the spawning beds the run would be maintained. If these closed seasons let just enough salmon reach the spawning beds for the perpetuation of the species, then the additional catching of the fish by trolling in the sea before they enter the rivers will be subjecting them to just that much overfishing, for if one-half of the run, we will say, is caught in the sea before it enters the river, the river closed season, instead of protecting one-third of the run as intended, protects only one-sixth of it. It is our belief that the closed seasons on the Sacramento River were not sufficient for the purposes of propagation even before sea trolling came into general practice. The fall season, instead of closing before the latter third of the run has entered the upper bays, does not close until after the last salmon are well up the river and no portion of the run escapes running the gauntlet of nets. This insufficient closed season, coupled with the increase of trolling at Monterey and off San Francisco, has resulted in a decrease in abundance of the Sacramento salmon. This decrease in abundance is shown in the fact that the number of salmon which reach the egg-collecting stations of the United States Bureau of Fisheries on the upper Sacramento River averages less than one-half that of a few years ago. At the same time, in spite of more energetic fishing, the commercial catch has not increased, even if we con-

sider all the salmon caught in Monterey Bay and off San Francisco as Sacramento fish. There is no question but that the Sacramento salmon need decidedly more protection if we are to save these fish from destruction. This need of added protection has been increased by a decision of the Superior Court of Contra Costa County which permits fishermen to net salmon on Suisun Bay and the lower Sacramento River during the summer closed season of June and July; and also by irrigation and power dams under construction and to be built which will shut off important salmon-spawning grounds lying above them.

Fishermen who fish with nets on the bays and rivers think that the sea trolling should be stopped or radically restricted, contending that the trollers are destroying the salmon by catching large numbers of immature fish. Salmon trollers, on the other hand, contend that the sea is the proper place to catch them and that after they have entered the river for the purpose of spawning they should not be caught. There is considerable merit to the arguments on both sides of this question. We are convinced that both methods of fishing need to be radically restricted, and that the time is now here when the laws should be made so as to best conserve the salmon and should not be compromised to suit different factions of fishermen on the plea that the state owes them a living. Salmon on the Sacramento need far more protection than they are getting under the present law, even if sea trolling is greatly restricted. Netting of salmon should not be permitted above the city of Sacramento, the summer closed season of June and July should be restored, and the fall closed season should close two weeks earlier.

It is true that a great many of the salmon caught by trolling are immature as is well shown in the paper on the "Relative Maturity of Salmon Caught by Trolling," in this issue, by Willis Rich. From investigations which have been made it is not clear that trolling is a more destructive method of fishing than is netting in the river. There are evidences which indicate that a salmon fishery may produce more pounds without depleting the supply if the fishing is carried on only in the sea. It is our belief,

however, that until our investigations throw more light on this subject, closed seasons should be established in the trolling districts during those times of the year when the majority of the immature fish are caught. These restrictions should not be so severe as to discourage the development of our sea fisheries, for the future expansion of our fisheries must be through sea fishing as our inland fisheries are now being taxed to their utmost capacity. Sea trolling for salmon, we believe, should be encouraged, for it is the most promising avenue through which sea fishing for other varieties of fish may be developed in the northern half of the state. The inauguration of salmon trolling a few years ago near Fort Bragg has resulted in fishing for other varieties of fish and it can be confidently predicted that within a few years we will have other fisheries there of more importance than the salmon.

EEL RIVER PROBLEMS

Just as the catching of salmon of the sea has been an added drain on the Sacramento salmon, so is the recent rapid growth of salmon trolling near Fort Bragg an added drain on the Eel River salmon, and fish of that river are in need of additional protection. This ocean catch is apparently having little effect on the run in the Klamath River, which is more than one hundred miles to the north.

It seems impossible to devise an open season for nets on Eel River which will satisfy the needs of the sportsmen, the commercial fishermen and the salmon culturist, and at the same time properly conserve the two species of salmon and the steelheads which spawn in the river. The Quinнат salmon begin entering the river early in September, and as there is rarely sufficient water before November to permit them to get above the pools near the mouth, these fish remain there in the fresh water and after a time become of little value for food, although they are still of value for propagation purposes. If the netting season is opened early and closed early so as to let the latter part of the run ascend the river unhindered to the spawning beds, and so as to take these early salmon while they are still fit for food, it meets with the violent opposition of the sportsmen, who contend that it

would ruin their steelhead fishing which is carried on in the lower river before the winter rains. If the open season for nets is moved to a time sufficiently late to permit these salmon lying in the pools to ascend the river beyond the reach of the nets, too many spawning steelheads and silver salmon, which begin entering the river about the first of November, would be taken. The present netting season of October 8 to December 7, inclusive, was a compromise season designed to meet the conservation requirements of the two species of salmon and the steelhead, and to partially satisfy the sportsmen and commercial fishermen. This open season has not satisfied the sportsmen or the commercial fisherman, and it has not met the needs of the salmon culturists; and, on account of the development of outside trolling, it does not meet the conservation needs of the Quinнат salmon.

The season is not sufficiently early to take the first part of the run before the fish become inferior for food purposes and it closes too late to let a sufficient number of fish reach the spawning beds up the river. On account of the depletion of the Sacramento run, salmon eggs can no longer be taken from that river to be used in stocking Eel River. If salmon culture is to be carried on in Eel River, the river must furnish its own eggs. Salmon racks can not be maintained in those parts of the river which are suitable for taking salmon for propagation purposes after the river is in flood, and it appears that the only feasible way in which eggs can be taken for this purpose is to permit the first of the run to ascend to the salmon racks after the first rise in the river, which is usually not sufficient to wash out the racks. If the netting season is placed sufficiently late to come after the first rise in the river and closes sufficiently early to avoid taking too many of the late running silver salmon—which date should not be later than December 1—the season would hardly be long enough to make netting profitable. We see no good way of harmonizing these varied interests. Whatever is done it should be seen to that the conservation needs of the three species of fish involved get first consideration.

NOTES FROM THE STATE FISHERIES LABORATORY.*

WILL F. THOMPSON, Editor.

CHANGES IN THE PERSONNEL.

Since the appearance of the last number of this magazine there have been several changes in the staff engaged in fisheries research.

Mr. John W. Rich, who has acted as field assistant in the albacore work at San Diego and San Pedro during the summer of 1920, has returned to Pomona College to resume his studies.

Mr. O. E. Sette, who has been with the Commission for more than a year, has also returned to his college work, having left for Stanford on September 1. He was stationed at Monterey observing the sardine fishery during the fall and winter fishing seasons, leaving there to act as field assistant at San Pedro in the work on the albacore during the summer months. At Stanford he will take up the study of subjects bearing on fisheries research and will at the same time prepare for publication the sardine data which he has collected. The Commission is fortunate in being able to retain the interest and services of Mr. Sette, whose work has been of high order.

To take the places of Mr. Sette and Mr. Rich, Mr. W. L. Scofield and Mr. Harlan B. Holmes have been added to the personnel of the laboratory. Mr. Scofield had been previously employed in research on the salmon and has been transferred to that on the sardine. He will be stationed at the Hopkins Marine Station in Monterey during the coming season, to carry forward the work already done by Mr. Sette. He is known to the readers of CALIFORNIA FISH AND GAME for several contributions made in past issues. Mr. Holmes has been a student at the University of Oregon, at Eugene; comes highly recommended, and with good training in biological work. He will be stationed at San Pedro, and will be engaged in the sardine work in company with Mr. Higgins.

Mr. Thompson will remain in general charge of the work, with temporary headquarters at Monterey. Mr. Higgins will remain at San Pedro.

Professor Weymouth, who has been engaged for several months in research on the Pismo clam, leaves on December 15 for Stanford University, where he will resume his teaching in physiology. He has one paper now in the hands of the printer and another in the process of writing. His work on the Pismo clam will prove of considerable value because of the great interest taken by the public in the preservation of that species, and because his work will prove of fundamental importance in the study of other mollusks.

THE SARDINE SEASON.

The sardine season opens inauspiciously this year, and it seems to be a serious question whether enough material will be obtained to complete our program of investigation for this year. No sardines were being taken at San Pedro at the time this note was written—December 8—and there was little hope held out by the cannerymen that very extensive packing would be resumed at any near date. At Monterey a number of the canneries have ceased operations, but up to the present at least no difficulty has been experienced in obtaining sufficient fish for our purposes.

What will happen in the future is not at present clear. There is no lack of fish at Monterey, and there is no reason to believe that they would be lacking at San Pedro if sought for. The reasons for the failure of the canneries to operate are given as a lack of orders, due very largely to the slump in export trade, and to the expectation of a falling market for sardines.

The sardine investigation, however, will not suffer vitally, even though the program for this year be disrupted, as there are enough data on hand to take considerable time in handling and interpreting. This program has been dealt with in the last issue of CALIFORNIA FISH AND GAME (Volume 6, No. 4, page 180).

*California State Fisheries Laboratory, Contribution No. 23.

CONFERENCES ON THE SARDINE WORK.

In order that the various assistants engaged in work on the sardine may thoroughly understand the program, we have instituted a system of conferences, in which the men engaged at Monterey and San Pedro meet as often as necessary, or more often if possible. The last conference was on the twenty-sixth and twenty-seventh of November, when Mr. Thompson, Mr. Weymouth, Mr. Sette, Mr. W. L. Scofield and Mr. Holmes were present. The purpose in this as on preceding occasions was to correlate the programs and to give everyone a thorough knowledge of them.

These conferences are inevitable because of the necessity we are under of educating the new assistants as they come, and of giving them an understanding of the fundamental reasons for the program we have adopted, if for no other cause. It is our hope that these assistants will be able—after the lapse of several years—to each take over entirely certain phases of the sardine or other problems, and to do this a thorough schooling is necessary. It has become obvious that a merely mechanical execution of duties by a more or less disinterested subordinate will not solve any of our fishery problems, and therefore we hope to give each worker a show in the rewards and penalties which come to the research man.

The inevitable period of training must include work under the senior assistants, but as fast as it is possible to place every investigator on a separate problem to make his own report this will be done, for it is recognized that no man works as well for another as for himself, and that there is no incentive comparable to that of professional success for which full credit is received. But until a thorough knowledge of the fundamentals is obtained such a course would be disastrous to any assistant, and hence the necessity of education.

The more immediate aim is, however, to have a discussion of all that bears on our problems and to make sure that the investigations at Monterey and San Pedro supplement and parallel each other where necessary. These conferences already held have proved of the utmost value in

formulating the programs of work, avoiding mistakes, and bringing to everyone's attention the observations made.—W. F. T.

THE PROGRESS OF THE NEW LABORATORY.

The building of the new laboratory at San Pedro has been definitely decided upon by the Commissioners, and the State Architect, Mr. McDougall, has the matter in hand. It is sincerely to be hoped that the building will be rushed, as we will face an embarrassing situation in the near future when the sardines begin to be taken at San Pedro, in that we will have to ask quarters from some cannery for our operations, the temporary laboratory being too far removed.

To those interested in the purposes of the new laboratory the statement concerning them in the last issue of CALIFORNIA FISH AND GAME, Volume 6, No. 4, page 177, will be of value.

THE HABITS OF SEA GULLS.

It is not an uncommon thing to have the presence of small fish in quantity regarded as the reason for the presence of great numbers of sea birds, especially sea gulls, at certain localities. Observation at Monterey has shown, however, that the great flocks of sea gulls frequently seen there during the winter occasionally appear on the days following a severe blow or other weather disturbance. This has not been investigated enough, however, to justify a positive statement, yet is highly suggestive in throwing light upon the belief mentioned as to their connection with the presence of young fish. The visits of the great flocks would seem to be due to the rough surf or wind on the outer coasts, when they are not present in both places in numbers during their migration.

That sea gulls are very sensitive to the condition of the water is strongly implied by an observation we have made upon them at Monterey. This observation has been repeated so often by laboratory members working there as to be beyond doubt. The water off such a lee shore as at Monterey is frequently streaked with light and dark areas, the light areas

being smoother and reflecting the sky more perfectly. These smooth light areas are always strictly avoided by the sea gulls (chiefly herring, western and glaucous-winged) for some reason, the flocks of gulls at rest on the water being invariably and sharply limited by the roughened dark water. This distribution of the flocks upon the water is for the purpose of resting, not feeding, and is invariable and exact. It is a most remarkable and strange fact. Whether the rough areas are caused by winds running counter to the currents or otherwise, the choice of such surfaces as resting places indicates unmistakably the sensitiveness of the gulls to the condition of the water, and thus throws some doubt upon the presence of food as the factor determining their presence.—W. F. T.

A FURTHER NOTE ON THE MONTEREY GULLS.

In the April, 1920, number (page 85) of CALIFORNIA FISH AND GAME, in an article on the "Gulls in Monterey Bay," it is pointed out that these birds, although diurnal in habit, were on one occasion observed to be feeding at night on sardines lost overboard while the lighters were being unloaded at the canneries. Such cases of night feeding are evidently not rare, for gulls in great numbers have been noticed recently on two occasions flying about the lighters in search of chance sardines dropped overboard. On one occasion the gulls were flying half an hour before daylight. The usual habit of the gulls is to spend the night on their roosting grounds, supposedly along the coast, and to appear suddenly at the canneries in large numbers with a regularity as to time that suggests an alarm clock, the time being just before daylight and

considerably before sunrise. On the mornings when this sudden appearance was timed it was found to vary but a few minutes from the scheduled breakfasting hour for Monterey gulls. On one other occasion gulls were noticed in large numbers at 10.30 p.m. (November 28) in bright moonlight flying about the sardine lighters. Fishermen and cannerymen say that the gulls have learned that the chances for a square meal are good whenever the sardines are being delivered to the cannery, and that it is no uncommon sight on moonlight nights to see hundreds of gulls flying about on the outlook for stray sardines. Just what amount of fish a gull considers to be a square meal is a question. One gull has been observed to swallow four large sardines in rapid succession and then fly off with ease. If the supply of sardines holds out more are swallowed until the bird is so weighted down that he is unable to fly, and must perforce walk or swim away to some quiet spot where the meal may be digested undisturbed. If confronted with the necessity of flying out of danger, the gull must lighten ship by disgorging his meal before taking to the air. Occasionally the sardine fishermen leave a lighter full of fish uncovered and unguarded, in which case gulls gather in the boat and eat until they are helpless. On the return of the fishermen the overloaded gulls allow themselves to be picked up and thrown overboard rather than disgorge away part of the feast. On one such occasion 65 gulls filled to capacity were counted as they were thrown into the air from a lighter and came down with a splash into the water. After a few feeble attempts to rise from the water these contented gulls swam off sedately, all headed for a sheltered stretch of sunny beach.—W. L. S.

LIFE HISTORY NOTES.

OPOSSUM KILLED ON
MOUNT HAMILTON.

Last night I killed a porch climber, in the shape of an opossum (*Didelphis virginiana*), here on Mount Hamilton. A few years ago a number of these animals were turned loose, or escaped, near San Jose, and they have since become established in the Santa Clara Valley. I was somewhat surprised, however, to find one at this distance from the original point of importation.

Mount Hamilton is at the summit of the range bounding the Santa Clara Valley on the east, and lies about thirteen miles, in an air line, from San Jose. It is separated from the Santa Clara Valley by two deeply cut watersheds: Halls Valley and Smith Creek. If the species keeps up its present rate of travel, it will be in the San Joaquin Valley within a few years, and from there will doubtless spread rapidly over the state. From the havoc this one created in the grapevine that marked the end of his particular trail, his relatives will not be very welcome guests to the vineyardists and other fruit men of the state.—W. H. WRIGHT, *Mount Hamilton, California.*

THREE MOUNTAIN LION KITTENS
CAPTURED.

About September 1, 1920, reports came to the Fish and Game Commission that there were mountain lions in the vicinity of Cathey Ranch, near Jerseydale, Mariposa County. I was sent to hunt the lions. I arrived at Jerseydale on September 10, and learned then that the lions had been heard screaming near the Cathey Ranch.

Never having heard the so-called scream of the mountain lion, and, in fact, having found them to be an invariably silent animal, I was much disappointed with this report. However, I spent two days hunting in the vicinity of Jerseydale without finding any sign of lions.

In the meantime, I telephoned to Ranger Malcolm McLeod and learned that cattle men had reported that they had seen some lion tracks several times on Owl Creek, near Devil's Gulch, eight miles northeast of Jerseydale. On the evening of September 12, I moved my outfit to the Mariposa Ranger's Station and the next day, while Ranger McLeod packed my equipment to camp on Owl Creek, I hunted on the way over to the

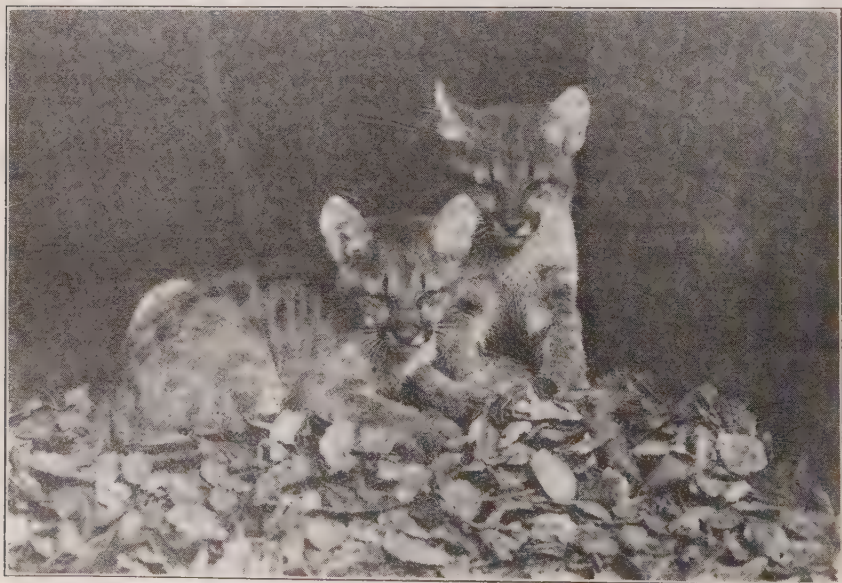


FIG. 27. Mountain lion kittens captured by Jay Bruce, state mountain lion hunter, in Mariposa County, September, 1920. Photograph by H. C. Bryant.

camp, then down the ridge on the east side of Owl Creek, and then to the east up Devil's Gulch and back to camp. I found old tracks of a female lion near the mouth of Owl Creek and in Devil's Gulch, but the indications were that the lioness had not been working these for several days.

The next day, September 14, I started to hunt in the country west of Owl's Creek, and about 7 a.m. my dogs picked up the fresh trail of the lioness going east toward Owl Creek. After trailing about half a mile my silent trailer, Ely, who was about two hundred yards in the lead of Ranger, the hound, jumped the lioness, which was indicated by Ely's barking.

The lioness ran down Owl Creek, going north for about a quarter of a mile, then treed in a live oak. I noticed that when Ranger arrived at the place where Ely found the lioness, he became confused for a few moments before straightening out the trail, but I was taking a short cut to where Ely was barking "treed" so that at the time I did not learn the cause of Ranger's confusion.

After shooting the lioness, the first thing that I noticed was that she had just been nursing kittens, as her breasts were still wet.

I skinned the lioness and afterwards back-trailed her tracks over the course that the dogs had chased her. When I reached the place where Ely had found the lioness, I noticed her fresh tracks going on toward Owl Creek and returning again over the same course; this explained why the hound had gotten confused.

The next thing was to find the kittens. After searching the brush and rocks for several minutes without success, and having in mind the track I had noticed going east from here and returning the same way, I decided that the kittens were somewhere farther east. Evidently, while the mother lion was nursing the kittens she heard the hound baying on her trail, about a quarter of a mile away, and left the kittens and back-trailed herself to meet the dog, but she was surprised by the silent dog, who was in the lead of the hound. Then she turned at right angles and led the dogs down the creek and away from the kittens. I now followed her tracks for about five hundred feet east and across Owl Creek to a bluff

of rocks, where the dogs scented the kittens, which were hiding in the small holes among the rocks. Two of the kittens were in one place and the other was about twenty-five feet from them in another hole. After considerable trouble I captured the kittens alive, and after taking off my shirt I carried them in it for about a mile to camp. From the camp I carried them in a barley sack for five miles to the Ranger's Station and then from there by auto to the office of the Fish and Game Commission in San Francisco.

The kittens were about six weeks old and were the size of an adult house cat. They weighed about eight pounds each and were twenty-six inches in length from tip to tip.

The home of the lions was on a ledge about seventy-five feet from the water of Owl Creek and near the top of a bluff of rock. This ledge, which was about sixty feet above the base of the bluff, was about five feet wide and extended about thirty feet along the north side and the same approximate distance along the west side of the bluff. Although there was no cave or den large enough to shelter the mother lion, this was apparently the place where the kittens were born and where they had lived until they were captured; as there were numerous beds, both on the north and west sides of the bluff, where the lioness had been lying on the ledge. The dry grass and moss all along the ledge was well worn and trampled, probably by the kittens while playing. The small holes among the loose rocks behind and above the ledge had evidently provided hiding places for the kittens when disturbed.—JAY C. BRUCE, *Oakland, California.*

HOW MANY EGGS DOES A SALMON LAY?

In the course of a study of King Salmon in Klamath River, it became desirable to learn how many eggs the female produces. Thinking that it may be of general interest, a table including the results of an examination of 30 individuals is given, the specimens being selected from a larger number as fairly representing the average.

Klamath salmon are somewhat smaller than those of the Sacramento, and it is

possible that the females produce fewer eggs. In a series of 3350 Klamath salmon the smallest female measured 20 inches and the largest 42. One either smaller or larger is rarely found.

The number of eggs here given were obtained not by actual count, but by weighing the ovaries, counting a small number of eggs, weighing the latter, and then calculating the entire number. Tests demonstrated that the method gave results accurate to 1 to 3 eggs in a 100. Ovaries from the same fish are not usually alike in size, the left being often somewhat larger than the right and containing as many as 200 or 300 more eggs. No very definite relation is seen between size, weight, or age and the number of eggs, although it will be noted that fish in the fifth year are found amongst those having most eggs.

Number of eggs	Length, inches	Weight, pounds	Age
2146	26 $\frac{1}{2}$	8 $\frac{1}{8}$	4
2700	31	11 $\frac{1}{2}$	4
2745	31 $\frac{1}{2}$	14 $\frac{1}{2}$	4
2847	30 $\frac{1}{4}$	12 $\frac{1}{4}$	4
2879	28 $\frac{3}{4}$	9 $\frac{1}{4}$	4
2949	30 $\frac{3}{4}$	13 $\frac{1}{4}$	4
3083	31 $\frac{1}{2}$	15	4
3110	33 $\frac{1}{4}$	17 $\frac{5}{8}$	4
3200	32 $\frac{1}{4}$	16 $\frac{1}{2}$	4
3305	28	10 $\frac{1}{2}$	4
3403	31	13 $\frac{1}{2}$	4
3467	32	15	4
3579	27	9 $\frac{1}{2}$	4
3586	29 $\frac{1}{2}$	12 $\frac{1}{2}$	4
3614	32 $\frac{1}{2}$	14	4
3630	32 $\frac{1}{2}$	15 $\frac{3}{8}$	—
3672	32	13 $\frac{3}{8}$	4
3676	32 $\frac{1}{2}$	15 $\frac{3}{8}$	4
3731	33	17 $\frac{1}{2}$	4
3781	32 $\frac{1}{4}$	14 $\frac{1}{2}$	4
3886	30 $\frac{3}{4}$	13	4
3935	33	15 $\frac{1}{2}$	5
4009	31 $\frac{1}{2}$	14	4
4117	37 $\frac{1}{2}$	26 $\frac{1}{2}$	5
4192	32 $\frac{1}{2}$	17 $\frac{1}{2}$	4
4197	30 $\frac{1}{2}$	13 $\frac{1}{4}$	4
4200	34 $\frac{1}{2}$	19 $\frac{3}{8}$	5
4300	32 $\frac{1}{2}$	15 $\frac{3}{8}$	4
4392	34 $\frac{1}{2}$	16 $\frac{3}{8}$	5
4842	34 $\frac{1}{2}$	18	5

Average number of eggs per fish, 3572.

—J. O. SNYDER, *Stanford University, California.*

FULVOUS TREE-DUCK SHOT NEAR COLUSA.

On October 16, 1920, while shooting ducks seven miles north of Colusa, the writer saw a flock of about twenty birds which came to the pond several times which were to him unknown. One of these birds was shot so that it might be identified, but when examined none of the party were able to name the bird. While discussing the specimen, Fish and Game Deputy Wm. N. Dirks happened by and identified it as a fulvous tree-duck. *Don- drocygna bicolor*. It was in fine plumage and is of particular interest because it is unusual for one to be seen so far north and at so late a date.—A. C. HANSEN, *Birds' Landing, California.*

BLACK FISH NEAR SANTA CATALINA ISLAND.

While doing patrol duty with the "Albacore," on November 18, 1920, I came upon a school of black fish (*Globio- cephalus scamoni*) near Santa Catalina Island, about ten miles north of Lone Point. I estimated that there were about one hundred individuals ranging between thirty and forty feet in length. They were going slowly northward. Unfortunately, I was unable to secure a specimen.

This large, porpoise-like mammal was formerly abundant off the coast of lower California and in the Gulf of California, but in more recent years it is not often seen. An oil made from the head of the black fish is highly prized for use in watches and chronometers. This oil is said to improve with age.—H. B. NIDEVER, *San Pedro, California.*

CONSERVATION IN OTHER STATES.

SANCTUARY FOR WILD LIFE DEEDED TO LOUISIANA.

A tract of land embracing 224,000 acres in Louisiana has been set aside as a perpetual bird sanctuary, and secondarily as a refuge for game, thus bringing to fruition the project of Edward Avery McIlhenny.

On November 8, 1920, deeds were signed in the office of the State Conservation Commissioner which gave to the state in fee simple Marsh Island, 79,300 acres in extent, which was purchased and presented by Mrs. Russell Sage; the Grand Chenier tract, 85,000 acres, purchased and presented by the Rockefeller Foundation, and the Ward-McIlhenny tract, 60,000 acres.

Years ago the plan for this reservation was thought out by Mr. McIlhenny, who first discussed the proposition with a friend, Charles Willis Ward. Mr. Ward supported the idea and as a result the Ward-McIlhenny tract was set aside as a wild life refuge. Mr. McIlhenny, encouraged in his plan to secure an adequate sanctuary for native and migratory birds, found a willing helper in Mrs. Sage. Soon afterwards he secured the appropriation from the Rockefeller Foundation and now the reservation is definitely assured to the state.

The Marsh Island tract lies in the Gulf of Mexico, off the coast of Iberia, St. Mary and Vermillion parishes; its eastern shores are famous as migratory bird haunts. The Grand Chenier tract is on the mainland and adjoins the Ward-McIlhenny tract and is close to Marsh Island. The Marsh Island and Grand Chenier tracts have been under the care of Commissioner Alexander of the State of Louisiana for the past six years, and this supervision has been so successful that it was finally decided to turn them over in fee simple to the state, along with the Ward-McIlhenny tract.

In the event of the discovery of any valuable ore or mineral, it is to be removed with the least possible disturbance to the wild life and the profits accrued must be used to further the protection of it, and if more money is made from this source than is needed for its original purpose, it is to be devoted to education or public health in the state.

VERMONT ESTABLISHES SANCTUARY FOR WATERFOWL.

The Vermont Fish and Game Commission has secured an option upon a tract of 900 acres of marsh land at the mouth of the Lamoille River, on Lake Champlain, as a sanctuary for waterfowl in their trips north and south through this much traveled migration route. The area has been investigated as to its properties for feeding the birds by the U. S. Bureau of Biological Survey and is considered ideal. It is expected that enough revenue can be derived from the trapping privileges to pay the salary of a caretaker; for the region abounds in muskrats, skunks, and other fur-bearing animals. This step is the first of its kind taken in any of the northeastern states.—*The Conservationist*, June, 1920.

VALUE OF PENNSYLVANIA'S ANNUAL KILL OF GAME.

The State Game Commissioner of Pennsylvania, John M. Phillips, through the statistics of the State Commission, estimated that there were 6,000,000 pounds of meat bagged as game last year which, at 20 cents a pound, would have a value of \$1,200,000. Three thousand buck deer were killed and 472 black bear. Mr. Phillips estimates that next year there will be 4000 deer killed and that the total weight of the game killed, including all smaller game, will be at least 8,000,000 pounds, which, at 20 cents, would be \$1,600,000.—*Field and Stream*, September, 1920.

QUEBEC LICENSES FUR DEALERS.

Canada is following the United States in the effort to conserve fur-bearing mammals. Recently, the province of Quebec took over entire control of its fur trade. Fur traders must take out licenses and report monthly all furs bought. The government imposes a small royalty on all skins before they can be stamped, and no unstamped skin may be sold or shipped out of the province on penalty of confiscation and fine. Trapping out of season is to be controlled, for obviously no inspector will stamp a skin which shows evidence of having been taken out of season. All shipments of skins not plainly marked on the outside will be confiscated and the sender fined. Thus, the poacher will be unable to market his illegally taken fur.

AUTOMOBILES CONFISCATED IN WISCONSIN.

The state of Wisconsin has a law which imposes on hunting violators not only a \$50 fine, but deprives these men of their guns, hunting licenses and automobiles. The confiscation of the automobile is a drastic and effective step, for it affords a stronger protection to the partridges and prairie chickens, which must be protected against the onslaughts of those who previously have been willing to "take a chance." They are more apt to think now what it will mean if they are caught.

THE SYSTEM OF CONSERVATION IN PENNSYLVANIA.

In an article published in the Bulletin of the American Game Protective Association, Mr. Holland states that the basis of the game protective system adopted by Pennsylvania is a combination of public shooting grounds and game refuges.

The first game preserve was established in Pennsylvania in 1905, and—quoting from Mr. Holland's report—"at the present time the state has twenty-four state game preserves, eighteen being on state owned forest lands and six on leased land that will eventually be owned by the state. These preserves are approximately nine miles in circumference and individually contain from 1700 to 3200 acres. Around each preserve are from 3000 to 7000 acres of land that is public shooting ground, on which any man may go and shoot, provided he complies with the laws of state and nation." According to the state laws, one-half of the total acreage of the state can be utilized in this way.

The game refuges have been placed as near as possible to the centers of population and in the center of state-owned forest lands, which during the open season constitute the public shooting ground. By this method the game is more readily protected when out of season. The preserves can not be mistaken, for a wire stretched waist high surrounds it, and often as many as six refuge posters can be seen from one point along the reserve. Too, fire protection clearings surround each area. The average cost of establishing a refuge is \$2,175, and the yearly cost

of maintaining the preserves total about \$1,174.

Aside from the larger preserves, there are the auxiliary state game preserves; which "are tracts of land, generally of 250 acres or more. They are cared for by the state, but are owned by some individual or a group of several individuals who are willing to donate or lease the land to the state as a game preserve for a period of ten or more years. A part of each tract is posted and cared for by the state and the balance is used for public shooting. These reservations may consist of farm lands. The plan has been found very beneficial where small game such as quail and rabbit are concerned."

The system of protection practiced in Pennsylvania to assure to the sportsmen an abundant supply of game seems to be eminently successful, and by 1921 Pennsylvania plans to have increased the number of her game preserves to forty.

THE PLATFORM ADOPTED BY THE ILLINOIS SPORTSMEN'S LEAGUE.

The annual meeting of the Illinois Sportsmen's League was held at Belleville, Ill., on May 14, 1920, and quoting from the Illinois Sportsman, the official organ of the League, the program which they are to support follows. It will be noted that the organization still maintains that the Federal Migratory Bird Treaty Act does not give the middle West a fair deal so far as duck hunting is concerned:

First—We are for the enactment of just and equitable game and fish laws and the vigorous and impartial enforcement of the same.

Second—We favor a program which will result in a better understanding between the farmer and sportsman.

Third—We feel that the number of game and fish wardens is inadequate and stand for an increase, also insist that efficient service be given at all times.

Fourth—Since the revenue from the sale of hunting and fishing licenses receipts for fines, etc., more than pays the operating expenses of the Illinois Division of Game and Fish, we ask that this surplus be kept intact in a special fund to be used for the conservation of our wild life.

Fifth—We stand for such an increase in game and fish as will furnish legitimate sport for every citizen.

Sixth—We favor the establishment by the state of recreation grounds which will be open to the public at all times

for either hunting, fishing, camping or other outdoor life sports.

Seventh—We will give our support to the Illinois Natural History Survey and State Forester in the preliminary work now being done for the conservation of what is left of our natural forests.

Eighth—We stand for a system of game refuges, and resting places for waterfowl; that is, in case public shooting grounds are obtained by the state, certain portions thereof shall be set apart where game can breed and raise its young without being molested by hunters, following the Pennsylvania plan.

Ninth—We stand for an extension of the fish rescue work now being done by the state, and feel that this could be made much more effective by the purchase or lease of certain lakes to be used for placing the smaller fish taken from the shallow bodies of water. When larger these fish could then be taken out and distributed for stocking purposes.

Tenth—We stand for a reduction in the bag and possession limits on all of our game birds and animals, this to be determined after a free discussion of the subject through the medium of this organization.

Eleventh—We stand for a change in the open season for the taking of our furbearing animals, preferably from November 15 to February 15.

Twelfth—We stand for a change in the open season on rabbits, preferably from November 10 to January 31; and in addition thereto believe a possession limit should be fixed. By delaying the

opening of the rabbit season and making it the first day of the open season for quail, there is a general feeling among the true sportsmen that many quail will be saved.

Thirteenth—Millions of dollars are being appropriated by the General Assembly at each session for the good of the people, therefore we are of the opinion that the question of establishing state parks should be given some consideration along this line. Next year we propose asking for a liberal appropriation, and request the cooperation of the people in general in obtaining the same.

Fourteenth—We consider roving dogs and cats one of the greatest existing menaces to our wild game animals and birds during the breeding season, therefore we favor the enactment of a law regulating the same.

Fifteenth—We stand for an amendment to the existing laws which will give the state additional powers in dealing with the pollution of the rivers and other streams of our state causing the destruction of our fish.

Sixteenth—The Migratory Bird Treaty Act has been upheld by the United States Supreme Court, therefore, it is the supreme law of the land, so the safe plan is to obey the same; however, we still maintain that the Middle West states are entitled to a late winter season during February and March for the shooting of waterfowl and hope to convince the United States Bureau of Biological Survey that this concession is due the sportsmen of this section of our country.

REPORTS.

VIOLATIONS OF FISH AND GAME LAWS.

July 1, 1920, to September 30, 1920.

Offense	Number of Arrests	Fines Imposed
Game.		
Hunting without license	23	\$340 00
Hunting on posted grounds	5	95 00
Deer—closed season—killing or possession	23	805 00
Failure to produce deer horns or skin	11	425 00
Running deer with dogs—closed season	1	25 00
Female deer—spike bucks—fawns—killing or possession	51	2,725 00
Illegal deer hides	2	75 00
Brush rabbits—closed season—killing or possession	19	410 00
Tree squirrels—closed season—killing or possession	2	50 00
Quail—closed season—killing or possession	19	615 00
Doves—closed season—killing or possession	13	385 00
Ducks—closed season—killing or possession	27	925 00
Sage hens—closed season—killing or possession	1	25 00
Nongame birds—killing or possession	5	110 00
Protected shore birds—killing or possession	4	200 00
Bear—closed season	6	105 00
Night hunting	1	25 00
Total game violations	213	\$7,340 00
Fish.		
Angling without license	9	\$230 00
Fishing for profit without license	42	430 00
Fishing in restricted waters	2	120 00
Illegal nets in restricted districts	29	600 00
Salmon—Saturday-Sunday fishing—excess daily limit closed season—taking or possession	2	200 00
Striped bass—underweight—excess daily limit and offering for sale closed season	28	505 00
Barracuda—undersized—taking or possession	1	25 00
Trout—excess limit—taking other than by hook and line	5	125 00
Clams—undersized—excess limit—taking or possession	8	250 00
Crabs—undersized—excess limit—taking or possession	7	95 00
Abalones—undersized—bringing to shore detached from shell	11	425 00
Dried shrimps—possession	5	165 00
Total fish violations	149	\$3,170 00
Grand total fish and game violations	362	\$10,510 00

SEIZURES—FISH AND GAME AND ILLEGALLY USED FISHING APPARATUS,

July 1, 1920, to September 30, 1920.

Game.		Fish.	
Deer meat	1,230 lbs.	Striped bass	1,125 lbs.
Doves	14	Halibut	600 lbs.
Quail	18	Barracuda	885 lbs.
Ducks	71	Salmon	55 lbs.
Rabbits	23	Perch	100 lbs.
Sage hens	2	Trout	12 lbs.
Deer hides	2	Crabs	377
Bear hides	1	Abalones	204
		Pismo clams	117
		Cockle clams	423 lbs.
		Dried shrimps and meal	6,300 lbs.
		Illegal nets	5

Searches.

Illegal fish and game

STATEMENT OF EXPENDITURES.

Period July 1, 1920, to October 31, 1920.

Administration:	
Commissioners	\$130 18
Executive officers	8,262 62
Printing	716 20
Research and publicity	1,605 58
Accident and death claims	776 40
	\$11,490 98
Commercial fish culture and conservation:	
Superintendence	\$4,836 25
Inspection and patrol	10,078 33
Research	11,009 75
Statistics	3,376 73
Market fishing license commissions	144 50
Propagation and distribution of salmon	9,600 12
	39,045 68
Sporting fish culture and conservation:	
Superintendence	\$5,272 57
Printing	99 05
Prosecutions and allowances	117 50
Angling license commissions	5,043 10
Fish exhibits	4,287 94
General patrol, pro rata share—	
San Francisco District (40 per cent)	12,883 72
Los Angeles District (40 per cent)	5,670 59
Sacramento District (40 per cent)	10,135 44
Propagation and distribution of trout	71,079 29
	\$114,589 20
Game conservation:	
Printing	\$124 26
Prosecutions and allowances	536 44
Hunting license commissions	9,630 50
Mountain lion hunting (and bounties)	2,566 40
General patrol, pro rata share—	
San Francisco District (60 per cent)	19,222 11
Los Angeles District (60 per cent)	8,505 93
Sacramento District (60 per cent)	15,201 59
	\$55,787 23
Tahoe camping ground	402 11
Total expenditures	\$221,315 20

[illegible]

All amounts shown in pounds unless otherwise specified.

CALIFORNIA STATE PRINTING OFFICE
J. M. CREMIN, Superintendent
SACRAMENTO, 1921

PATROL SERVICE.

SAN FRANCISCO DIVISION.

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J. S. Hunter, Assistant Executive Officer.

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E. C. Boucher	San Francisco	B. H. Miller	Ukiah
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Geo. Neale, Assistant.

Forum Building, Sacramento.

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Union League Building, Los Angeles.

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1919 ABSTRACT CALIFORNIA FISH AND GAME LAWS 1920

WHITE SQUARES INDICATE OPEN SEASON
NUMBERS IN SQUARES ARE OPEN DATES

	DISTRICTS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	BAG LIMITS, ETC.
DEER	1-11-41 23-24-25-26								15	14				No Does, Fawns or Spike Bucks. No sale of venison. Two Bucks per season. See Notes 1-2-8-9-10-14
	2-3									14				
	4								15	15				
												15		
RABBITS, Cottontail and Brush	ALL													15 per day. 30 per week. No limit in District 4
TREE SQUIRRELS	ALL													12 per season
ELK, ANTELOPE, MOUNTAIN SHEEP	ALL													Killing of Elk or possession of Elk meat a felony
SEA OTTER, BEAVER	ALL													\$1,000 fine for Sea Otter
BEAR, FUR ANIMALS	ALL										15			See Notes 11-12
DUCKS, GESE, JACK SNIPS, MUD HENS	ALL										15			See Notes 4-14-15-17
RAIL, WOOD DUCK, WILD PIGEON, SHORE BIRDS (Except Jack Snipe)	ALL													
QUAIL, Valley and Desert	1-11 2-3											15		15 per day. 30 per week.
	4-41										15			
	1-11													
	2-3											15		
MOUNTAIN QUAIL	4-41										15			10 per day. 20 per week.
	ALL Except 4									15				
	4													
SAGE HEN	ALL													4 per day. 8 per week.
DOVE	ALL													15 per day. 30 per week.
GROUSE	ALL									15	14			4 per day. 8 per week.
TROUT (Except Golden), WHITE FISH	1-12a-12b													See Note 44 50 fish or two pounds and on See Note 43 fish or one fish weighing ten See Note 45 pounds or over See Notes 24 37-39 See Note 26
	11													
	2													
	3													
	4-41													
	Lake Almanor													
	23-24-25							30						
GOLDEN TROUT	ALL							30			1			20 per day. None under 5 inches.
	ALL													25 per day. None under 7 inches.
BLACK BASS	Clear Lake in Lake Co.													No sale. Hook and line only.
SACRAMENTO PERCH, SUNFISH and CRAPPIE	ALL													25 per day. Hook and line only.
STRIPED BASS, SHAD	ALL													See Note 23
SALMON	ALL Except 15													See Notes 27-46
	15							15						
CATFISH	ALL							14		15				Closed season only for commercial fishing
CRABS	ALL							30				15		See Note 28
ABALONES, Red	ALL													See Note 33
Green, Pink, Black	ALL													
PISMO CLAMS	17													See Note 32

HUNTING LICENSES

License Year from July 1 to June 30

Residents, \$1.00. Non-residents, \$10.00. Certain Aliens, \$10.00. Other Aliens, \$25.00.

ANGLING LICENSES

License Year from January 1 to December 31

Residents, \$1.00. Non-Residents, \$3.00. Aliens, \$3.00.

TRAPPING LICENSES

License Year from July 1 to June 30

Citizens, \$1.00. Aliens, \$2.00.